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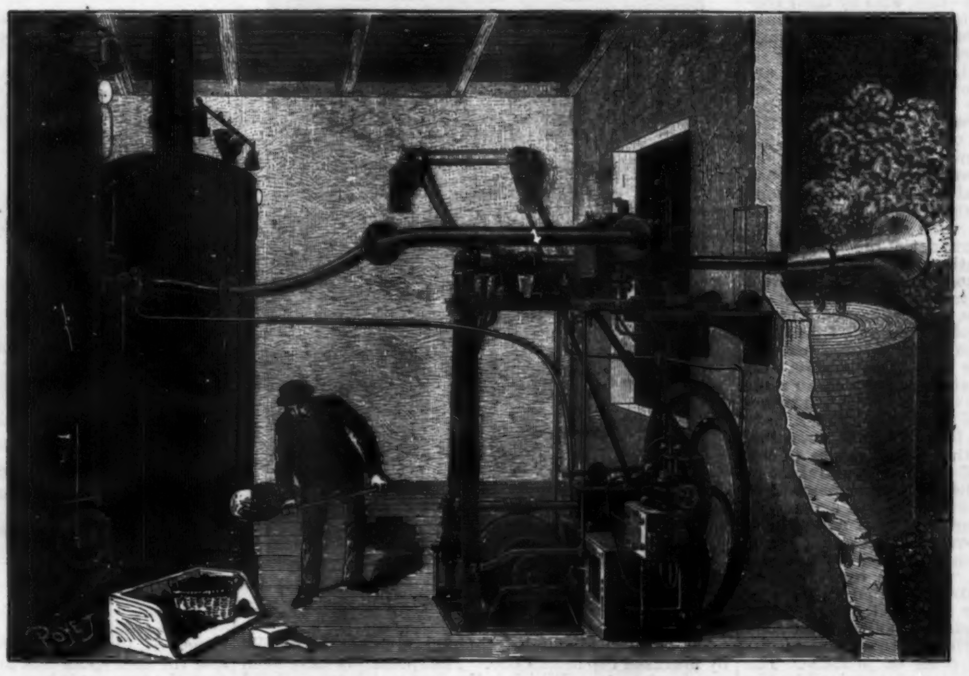
THE LOSS OF THE CHANNEL STEAMER VICTORIA.

On April 12 the London and Brighton Railway Company's steamer Victoria left Newhaven for Dieppe at 11:30 P. M., with about ninety passengers on board. All went well until about four in the morning, when, a thick fog having come on, the captain was unable to see the land, and sent the second mate to the engine room to ascertain the number of revolutions the engines had made. From these he concluded that the vessel must be off the land, and then, suddenly seeing the cliffs ahead, reversed his engines. Not hearing the fog horn which is usually sounded in thick weather off the Pointe d'Ailly—a headland some nine miles west of Dieppe, beneath which stretches far out into the sea a dangerous line of rocks—the captain concluded that he was eastward of Dieppe harbor, and accordingly, after having backed his vessel for some distance, ported his helm and proceeded ahead. In reality the vessel was off the Ailly rocks, and in a few minutes she struck with a tremendous crash, her bows being ripped open and the water flowing rapidly into the fore cabins. Fortunately most of the passengers were dressed, as the chief mate had just gone round with the landing tickets, and had informed them that they were nearing the harbor. A wild panic seems to have ensued upon the vessel striking, despite the attempt of Captain Clarke and his officers. The captain at once ordered the boats to be lowered, but, owing to the rush and the jamming of the pulleys by a lady's shawl, the first boat—the port quarter boat—was capsized, and all its occupants thrown into the water, some of them being rescued by the second boat which was lowered. The second and third boats were then filled and dispatched to find the nearest land, and then the second mate, Mr. Pope, took as many as he safely could on board the fourth boat, and rowed as near to the beach as possible. He then ordered the men to jump into the water and to wade ashore, the women being carried through the water in the men's arms. Returning to the ship, he took off another boatload until all were rescued, Captain Clarke coming off in the fifth and last journey. The passengers testify highly to the conduct of the captain and his officers, and state that had there been no panic, very little loss of life would have occurred. The chief engineer, Mr. Moneypenny, also, when the engine room was rapidly filling with water, gallantly rushed into it and turned off all the cocks to prevent any explosion. The incoming tide rapidly swept over the vessel, until in a few hours nothing but her funnels were visible. On landing, the passengers were treated with much kindness and sent on to Dieppe, where subsequently they were joined by the occupants of the other two boats, who had been landed at Fecamp. They had been perceived when off St. Valery en Caux, but were warned by the fishermen on shore not to attempt to enter the harbor, as the sea was running too high. Their appearance, however, was at once telegraphed to Fecamp, whence the lifeboat was dispatched to their relief. As soon as the lifeboat reached them they were taken on board, and being subsequently transferred to a tug were brought to Fecamp. The reason why the fog horn did not sound appears from the account of the head lighthouse keeper to be due to the extraordinary neglect of the man on watch. He himself had been awakened by his wife, who had perceived the fog at ten minutes past four; but as the horn is blown by steam the fire had to be lighted, and an hour elapsed before it could be brought into action. Had he been able to blow the horn without delay, the disaster would in all probability have been averted. The wreck was not perceived until six o'clock, but the keepers state they had heard the cries of the people at half past four, but had never suspected the cause. Twenty-six of the passengers and crew are thought to have been lost by the capsizing of the first boat, but the exact number has not been ascertained. One lady and two of her children were drowned—one little boy being saved. A few of the bodies have been recovered and claimed by their friends, but the greater number are still missing, and it is thought that the bodies of some third class passengers who had no time to escape may be found by the divers. Our illustrations show the engine room of the steam fog horn building and its machinery; also the exterior of the building.—*London Graphic.*



ENGINE ROOM OF THE FOG HORN OR STEAM SIREN, POINTE D'AILLY.

BUSINESS PROFITS.

Gen. Francis A. Walker, of the Massachusetts Institute of Technology, lately delivered a lecture before the Society of Arts, Boston, his subject being "The Source of Business Profits." The speaker stated and explained his theory of the origin of business profits, brought forward in 1883 in his treatise on political economy. Gen. Walker said in brief: It is not to be disputed that, if this theory be a correct one, it supplies just what was lacking, and yields, in conjunction with well approved theories of rent, interest, and wages, a complete and consistent body of doctrine regarding the distribution of wealth.

We shall best approach our present subject by inquiring what would be the share of the produce going to the employer, as such, irrespective of the proper interest on capital, in case the body of employers constituted a distinct class, either naturally or artifically defined, all of whose members were equal among themselves in the point of business abilities and opportunities. We assume that in a certain community there are a number of employers who alone are permitted to do the business of that community, or else who are so exceptionally gifted and endowed by nature for performing this industrial function that no one not of that class would aspire thereto, or would be conceded any credit or patronage should he so aspire. Secondly, we assume that, neither in point of ability, nor of opportunity, has any one member of this class an advantage as against another. What would be true of business profits, the remuneration of the employing class? I answer that, if the members of this class were few, they might conceivably effect a combination among themselves; and through possessing a natural or an artificial monopoly of a force absolutely indispensable

THE STEAM FOG HORN OR SIREN, POINTE D'AILLY, FRANCE.

to the conduct of industry, they might fix a standard for their own remuneration, which should be the price for which they would consent to carry on the business of that community. If, however, the community were a large one, and this business class numerous, such a combination to determine profits would be impracticable.

Competition would set in, and would find no natural stopping place until it had reduced profits to that minimum which, for present purposes, we call *nil*. The ultimate minimum would be the amount of profits necessary to keep alive a sufficient number of the employing class to transact the necessary business of the community. We have supposed that laborers could not become employers, but it does not follow that employers might not become laborers, and earn the wages of laborers, in case their remuneration as employers should be reduced by competition below the current rate of wages. In this case the minimum of profits would be determined by the current rate of wages. In the case assumed, the remuneration of the employing class would infallibly be reduced through the normal effect of competition to a level with the remuneration of the laboring class. There would be no profits as distinguished from or preferred to wages. Do we actually find employers of labor earning profits which are no greater than the wages of labor? I answer that in every large community there are many such employers, and in every branch of business in a large community there are some such employers—men who by their conduct of the industrial enterprises of which they have come into control, realize no remuneration greater than that received by the laboring class.

We may take a step beyond, and say that there are some whose conduct of business results only in loss. Just above this class are those employers who realize, at best, but very moderate profits, which may, for the purposes of this discussion, be taken as *nil*, amounting, that is, to little if anything more than the same persons might hope to receive in the employ of others, and that too, with much less of mental pressure and nervous wear and tear. Taking our stand on this line, we see the body of employes viewed with respect to the remuneration received for the conduct of business, rising upward by insensible graduations, but through long distances, until we come to those rarely gifted masters of industry who are capable of managing the largest enterprises with uniform success, and who seem to turn everything they touch into gold. We note that these employers, as a rule, pay wages equal to those paid by those who realize no profits, or even sustain a loss, and they pay as high prices for materials and as high rates of interest for the use of capital if the scale of their transactions and greater security of payment be taken, as it should, into account. Whence, then, comes this surplus, which is left in the hands of the higher grades of employers after the payment of wages, the purchase of materials and supplies, and the repair and renewal of machinery and plant? I answer that this surplus represents, in the case of the employer, that which he is able to produce over and above what an employer of the lowest industrial grade can produce with equal amounts of labor and capital. It is his own creation, produced by that business ability which raises him above employers of what may be called the no profit class. Well approved principles of political economy will not allow us to question that, in this view, profits do not enter at all into the price of produce. The normal price of any kind of goods is determined by the cost of that last considerable portion of the supply which is produced at the greatest disadvantage. The cost of maintaining employers of the lowest industrial grade necessarily enters into the normal price. The cost of that portion of the necessary supply which is produced under the direction of this class fixes the price of the whole supply, and those who produce at a relative advantage have left in their hands a surplus, after paying wages, interest, and rent at rates equal to those which are paid by employers who realize no gain. That profits are not obtained by deduction from wages is equally clear, when we consider that the most successfull employers pay as high wages as the employers who realize no profit.

If the view here presented be a correct one, it will appear that it is for the interest of the community, particularly of the wages class, that the conduct of industrial enterprises should be restricted to men of distinct, decided business ability. If this be correct, we see how mistaken is that opinion, too often entertained by the wages class, which regards the successful employers of labor, men who realize large fortunes in manufactures or trade, as having in some way injured or robbed them, while extending to the less successful employers of labor a considerable degree of sympathy. Economically this is mistaken and mischievous. The men who do business at the cost of the working classes are the men who do business poorly. Ignorance, inertness, and improvidence on the part of the working classes greatly increase the opportunities for incompetent men to crowd themselves into the control of labor and capital and to conduct industrial enterprises at the cost of the general community.

After the three succesive deductions from the produce of industry—rent, interest, and profits—there remain wages. In this, profits, the remuneration of the employing class is determined by principles closely analogous to those which determine rent. In this view they constitute a part of the price of goods, and are obtained through no deduction from the wages of labor.

Wages is the residual share of the product of industry—residual in this sense, that it is enhanced by every cause which increases the product of industry, without giving to any one of the other three parties to production a claim to an increased remuneration; residual in the sense that, even if any one or all of the other parties to production become so engaged in any given increase of the product as to become entitled to an enhanced share in its distribution, their shares still remain subject to determination by positive reasons, while wages receive the benefit of all that is left over, after the other claimants are satisfied. It is demonstrated that the product of industry may be increased without enhancing the share of all or of any of the other parties to distribution.

The wages class then receive a benefit from any increase of the product of industry corresponding to that derived by the residuary legatee whenever the total value of the estate concerned is ascertained to have been, or by some unanticipated cause becomes, larger than was in contemplation of the testator when the amounts of the several specific bequests were determined upon.

The theory here offered accounts, I believe, for the actual facts of business profits, about as nearly as the Ricardian doctrine accounts for the actual facts of rent. This is all that is claimed for it. If so much be conceded, it must, I think, be seen that we have for the first time since the wage fund theory was exploded, a complete and consistent theoretical determination of the several principal shares into which the product of industry is divided. If profits are not divided as here stated, will not some one undertake to show whence they do come, and by what forces they are determined and limited as to amount?

THE PROBLEM OF THE MATCHES.

ONE of our contributors, who wishes his name withheld from publication, sends us a description of an amusing experiment which he designates as a "rejoicing over matches that refuse to take fire."

Four chemical safety matches are taken from a box, and two of them are inserted in the space between the box and the partially open slide, while the third is placed between the other two, as shown in the figure. This latter match must be held very firmly between the other two, which are bent back from their initial position for this purpose.

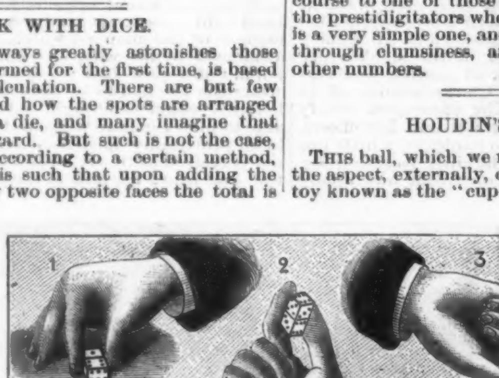
THE PROBLEM OF THE MATCHES.

The horizontal match is then set on fire in the middle by means of the fourth one. The spectators have been previously asked, Which is the first match whose head will take fire? Is it the one to the right or the one to the left?

Answer: Neither. As soon as the match is carbonized, the two lateral ones will spring back and throw it out with considerable force, so that it will be extinguished. Our figure so well shows how things are arranged for the experiment, that it is useless to enter into further detail. In case the matches do not readily enter the free space between the box and slide, they may be beveled off at the lower end.

A TRICK WITH DICE.

THIS trick, which always greatly astonishes those before whom it is performed for the first time, is based upon a very simple calculation. There are but few persons who understand how the spots are arranged upon the six faces of a die, and many imagine that they are placed at hazard. But such is not the case, for they are disposed according to a certain method, and their arrangement is such that upon adding the number of spots on any two opposite faces the total is always 7. This is the starting point of our trick, which is played with two dice, whose opposite faces when added will of course give a total of 14 spots.



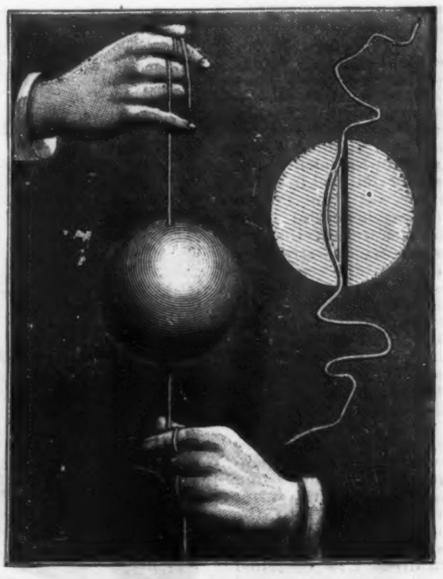
A TRICK WITH DICE.

The trick is as follows: After throwing the dice and ascertaining the number of spots obtained, say 5, for example, they are grasped between the thumb and forefinger, as shown in Fig 1. The operator, through a simple mental calculation, already knows that the number of spots beneath is 9, but he takes care not to show them. While quickly turning his hand over to the position shown in Fig. 3, he gives the dice a quarter turn by a twist of his fingers, as shown in Fig. 2. He then shows the spectators a number of spots, say 8, for example, that they will think are those of the bottom, but which are really those of one of the lateral faces. He calls strict attention to the number, and then quickly brings the dice back to the first position by reversing the former action of the thumb and forefinger (Fig. 4). A person can very easily acquire the faculty of making these motions very rapidly, and of rendering them almost imperceptible while the hand is passing from one position to the other.

The operator now says: "I have just shown you that the number of spots beneath is 8. Well, I am going to change that number by adding one to it;" and he asks one of the spectators to strike the under surface of the dice with his forefinger, as if to fasten the supplementary spot to it. Upon laying the dice on the table (Fig. 5), he calls attention to the fact that he is doing nothing that could disturb them, and that the number of spots on top is the same as it was in the beginning. He then invites some one to turn the dice over, when it is observed with astonishment that there are 9 spots instead of 8.

It is clear that, in certain cases, instead of adding one or more spots, it will be necessary to subtract some. If, for example, we have 12 in the beginning, and the false spots that are shown are 9, since we know that the true spots beneath are 2, we shall have to ask the person called upon as an assistant to efface 7 spots with his finger, instead of adding any.

Finally, there are certain positions of the dice with which the trick cannot be played, and this is when the false spots and the true spots beneath are equal. Thus, when the spots beneath are 10, through 6 and 4, so that the lateral faces against the thumb carry fives, it is found that we have 4 for false spots (by two twos), and the same number for true spots beneath (by three and one). In such a case it becomes necessary to have recourse to one of those many subterfuges employed by the prestidigitators when they are embarrassed. There is a very simple one, and that is to let the dice fall as if through clumsiness, and then to begin again with other numbers.



HOUDIN'S MAGIC BALL.

HOUDIN'S MAGIC BALL.

THIS ball, which we recently saw in a toy shop, has the aspect, externally, of the one used in the familiar toy known as the "cup and ball." Extending through its center there is a straight cylindrical aperture, and when a cord is passed through the latter, the ball easily slides along it.

If a person who is in the secret holds the cord by its two extremities, things change, since the ball, far from falling, descends very slowly along the string, or even remains stationary, and does not move again until the operator allows it to. This trick, which was formerly

performed by Robert Houdin with a ball of large size, very much surprised spectators.

How does the affair work? That is explained in the section of the magic ball shown in the figure. In addition to the central aperture, there is another and curved one, which ends near the extremities of the axial perforation, and a person in the secret, while making believe pass the cord through the straight aperture, actually passes it through the curved one. It will now be apparent that it is only necessary to tauten the cord more or less in order to retard or stop the descent of the ball.

To the left of the engraving is seen the magic ball thus suspended between the operator's hands.

The above, together with "The Problem of the Matches" and "A Trick with Dice," are from *La Nature*.

THE NEW UNIFORM FOR THE FRENCH INFANTRY.

IT is known that the first action of the war department was to order a new uniform, which had been tried in a few regiments, and the description of which had been sent to all the chiefs of division. The opinions of these latter were submitted to the war department, which decided—after a long examination, and after having ascertained the opinion of the Committee on Infantry—to submit to Parliament a project for a new uniform for the infantry.

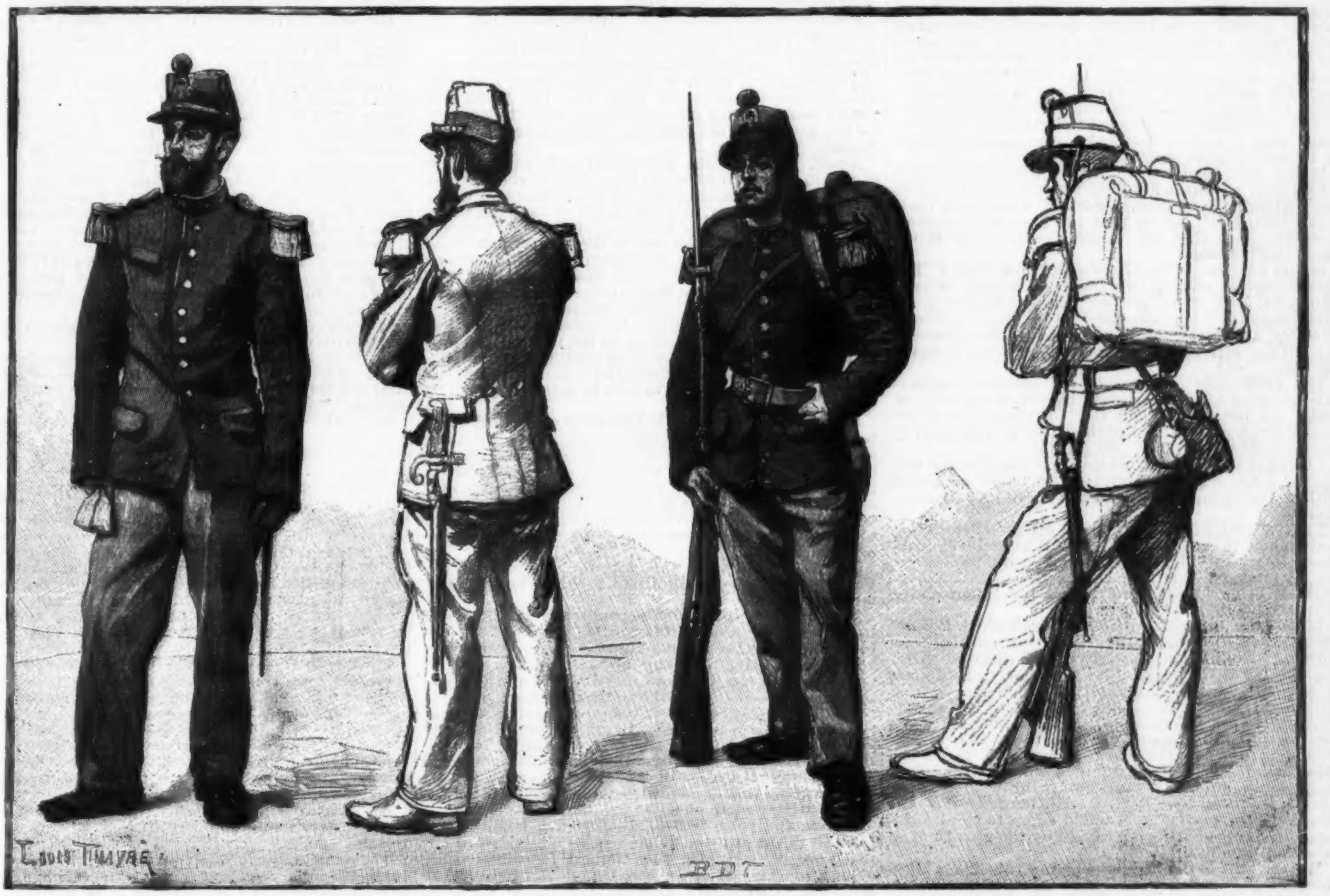
The following is the project referred to:

1st. The adoption of a "tunique-vareuse" for full dress and fatigue uniforms. The vest is given up.

The new tunic is loose, and facilitates the soldier's movements of respiration. It contains inside pockets for the book containing his credentials, and outside pockets for cartridges. The cartridge boxes are no longer used.

The belt is worn underneath, and it and the sword holder are still of black leather. The outer garments are sufficiently loose to permit of wearing woolen under-garments.

The epaulets of the infantry are to be retained temporarily, or until the present supply, which is quite large, is exhausted.—*Le Monde Illustre*.



THE NEW UNIFORM OF THE FRENCH ARMY—NO CARTRIDGE BOXES.

ACUTENESS OF HEARING.

AT a recent meeting of the Physiological Society, Berlin, Prof. Du Bois-Reymond in the chair, Dr. Konig spoke on acuteness of hearing and its estimation by means of tuning forks, the sound of which gradually died away. He laid stress on the distinction between acuteness of seeing and acuteness of hearing, the latter of which was represented by the time from the beginning of hearing a tuning fork struck till no sound from it was any longer perceived.

It was now customary to say when one person could hear a certain tuning fork for 100 seconds after it had been struck, and another could hear the same tuning fork, struck at the same intensity, for only 50 seconds, that the second had only half the acuteness of hearing possessed by the first. In point of fact, such a statement was not accurate, seeing that the amplitudes of a vibrating tuning fork declined in geometrical progression. It was only in very special circumstances that the specification of the amount of acuteness of hearing, as commonly employed, could be correct.

As an empirical method of measurement according to a conventional standard, the expressions a half, a quarter, or whatever be the measure, of acuteness of hearing would be permissible, if in such cases the same tuning fork were always applied, and it was always struck with the same intensity. To come to an understanding on this point was the business of practical aurists.

During the animated discussion which followed this address, Prof. Du Bois-Reymond produced an apparatus in which equal amplitude of vibration in a tuning fork was obtained by placing between the prongs of the fork a revolving elliptical disk of such dimensions that the small axis left the prongs in their natural position, while the large axis forced them apart from one another. The large axis having been put in, and the disk rapidly turned through 90°, the fork commenced to vibrate, and with each impulse the amplitude was the same.

THE SIMILARITY OF THE PHENOMENA OF THE NERVOUS SLEEP, HYPNOTISM, SPIRITUALISM, TO THE PHYSIOLOGICAL ACTION OF CANNABIS INDICA OR HASHISH.

By A. L. HODGDON, M.D., Farmwell, Va.

THE hashish has long been employed by the Malays as a means of producing a peculiar kind of intoxication, and the ecstatic state produced by the same undoubtedly bears, in many ways, a close resemblance to the results manifested by inducing the so-called condition, hypnotism. It has been variously classed among the narcotics, etc., by different writers, but the classification made by Fonssagrives* seems to indicate its character very clearly, viz., primarily classed among the "delirants;" secondarily among the "cannabiques." The beautifully written description by Professor Wood† of the effect produced by a full dose taken by himself seems to indicate its general action, although of course there are many exceptions to the action produced in individual cases.

Hypnotism,‡ or the sommeil nerveux of Demarquay (the last term appearing to be the preferable one), with its long line of allied states and synonyms, *i. e.*, catalepsy, mesmerism, and the so-called spiritualistic manifestations made manifest by clairvoyance through the medium of the nervous sleep, which attracted considerable attention when announced by Mesmer about the year 1772.

Alexander Dumas § gives a glowing account of the doings of one Balsamo or Count Cagliostro, whose preceptor was Althotas, while Carlyle ‖ in describing an effigy of him writes thus: "Fittest of visages; worthy to be worn by the quack of quacks! A most portentous face of scoundrelism—a fat, snub, abominable face; dew lapped, flat nosed, greasy, full of greediness, sensuality, oxlike obstinacy; a forehead impudent, refusing to be ashamed; and then two eyes turned up seraphically languishing, as in divine contemplation and adoration; a touch of quiz, too; on the whole, perhaps the most perfect quack face produced by the eighteenth century. There he sits, and seraphically languishes with this epigraph:

'De l'ami des humains reconaissez les traits.
Tous ses jours sont marques par de nouveaux bienfaits.
Il prolonge la vie, il secourt l'indigence;
Le plaisir d'etre utile est seul sa recompense.'"

Yet there are people to-day, in this enlightened age, who look upon the phenomena of clairvoyance and implicitly believe that spiritual manifestations are produced through the same; the reason they believe it is hard to explain, unless it is, as Dr. Maudsley* says: "In like manner, at the so-called spiritual seances, the idea of an event being about to happen will produce in some persons a conviction that they actually see or feel it happen.

"A person of a certain sort of nervous temperament, sitting in the dark for some time in complete silence, having the feeling of some mysterious agency at work, and eagerly expectant, gets into such a state of mind that he is ready to perceive what he is confidently assured will occur, and perceive it accordingly when what really occurs was perhaps something quite different. The rule of sound observation is that the mind should be free from a preconceived idea; the rule of those who call spirits from the vasty deep is that the mind should be possessed by the preconceived idea."

There are some phases connected with the nervous sleep that seem at most unexplainable, but in legerdemain as well there are things that puzzle the most acute of observers; for example, in a somnambule who came under my immediate observation, while in the mesmeric sleep (having the eyes closed), upon being asked the hour (although there was at the time a clock in the room and a watch in the pocket of the subject), gave in response the time that was between the time indicated by the clock and that of the watch, it being afterward ascertained that the clock was a few minutes too fast and the watch a few minutes too slow. But upon questioning the subject, who was a very intelligent person, and was not prone to give way to superstition, it was found that he was very good at a guess in reference to the time. Dr. Tuke,† however, gives so many instances in his most elaborate work of the influence of the mind upon the body, that it is scarcely to be wondered at that a party having a firm conviction that he will see something, would after a while have a hallucination; and ever afterward have it engraved upon his mind that he had seen what he had been looking for. But for all who are inclined to look upon the subject in a natural light, and not to gaze at the same through the dim vista of the supernatural, they could not do better than read Dr. Carpenter's ‡ admirable little work.

Now, taking hypnotism as a scientific phenomena, you have in it something more tangible to compare with the action of hemp. We know in the first place that both hypnotism and hemp produce a sense of double consciousness in the person who comes under their influence, both have an anagelsic action, and both, in some degree, an anæsthetic one; both are characterized by a tendency to produce hilarity, and at

* Principes de Therapeutique Generale. Second edition. Par J. B. Fonssagrives.

† Therapeutics and Materia Medica. Wood.

‡ Recherche sur l'Hypnotisme ou sommeil nerveux Demarquay et Giraud Teulon.

§ Memoirs of a Physician, by Alexander Dumas.

‖ Critical and Miscellaneous Essays, by Thomas Carlyle.

* Physiology of Mind, Maudsley.

† Tuke's Influence of the Mind upon the Body.

‡ Mesmerism, Spiritualism, etc.; Historically and Scientifically considered, by William B. Carpenter, C.B., M.D., LL.D., etc.

times pugnacity, while a sense of *bien etre* is noticed to be produced by both; a sensation as of an electric current passing through different portions of the body is noticeable in both. The party under the influence of either is largely influenced by his surroundings; and, finally, the action of the hashish corresponds to that of the nervous sleep by leaving no malaise in its wake like one notices so often to follow a dose of opium. Both greatly tend toward the production of catalepsy, one of the phases of the mesmeric state.

Hypnotism has been largely given over to clairvoyants, instead of being scientifically investigated to any great extent, while the investigation of the action of hashish has not received the attention it has merited in comparison with other drugs.—*Maryland Medical Journal.*

[Continued from SUPPLEMENT, No. 595, page 9506.]

CLIMATE IN ITS RELATION TO HEALTH.*

By G. V. POORE, M.D.

LECTURE III.—CONTINUED.

PHTHISIS.

THERE is no disease with which we are more familiar than tubercular disease of the lungs—consumption, or phthisis, as it has been called. It is a disease which has been the opprobrium of medicine, and which, when well established, is rarely recovered from. The views as to the nature of the changes which take place in the lungs have been almost as varied as the writers have been numerous. And it is only within the last few years that we have arrived at anything like a fixed opinion as to the nature of the disease. This advance has been due to Koch, the eminent physician and sanitarian of Berlin, who seems to have proved that there is always to be found in association with tubercular disease a micro-organism which he has called the *bacillus tuberculosis*. There is no doubt about the bacillus. Koch having shown the way, we none of us have any difficulty in finding it. It is not present in those forms of lung disease which are not tubercular, but it is invariably associated with tubercle wherever found, and it is easily detected in the matter coughed up by consumptive patients.

It has long been known that tubercular disease is infective, *i. e.*, that a localized focus of the disease in any part of the body might infect the whole body; and it has been lately shown that the disease is definitely inoculable, and that the *bacillus tuberculosis* is probably its true cause.

Is the *bacillus tuberculosis* a fact or a fancy? The importance of settling this question cannot be overestimated, for if it be proved that the bacillus is the actual cause of tubercular disease, that consumption is, so to say, a zymotic, our attitude toward the disease in the future will be very different from what it was in the past.

The arguments in favor of the bacillary cause of tubercle seem to me to be as strong as they can well be, and it is a noteworthy fact that the acceptance of the theory by physicians and pathologists in this country becomes daily more and more general.

I think it will be conceded also that many of the well known facts regarding phthisis are more in accord with its being an infective than a local inflammatory disorder.

That a local tubercular deposit will infect the whole body much in the way that a foul wound will sometimes infect the whole body is well known; and arguing by analogy, this is a strong reason in favor of phthisis being an infective disease, dependent on the growth of an organism.

When once tubercular disease is established, it is not often recovered from. A man contracts phthisis from working in an ill-ventilated, crowded workshop. After the disease is fully established the chance of stopping it is small, notwithstanding that he be removed from the conditions which caused his trouble. If the case were due to the chemical or mechanical foulness of the air starting inflammatory action, then the disease should stop when the cause is removed. If, on the other hand, bacilli have found a home in the lungs, they would probably continue to grow after their growth had been once started. The persistence of the disease when once it gets a hold seems to be an argument in favor of its being caused by the growth of an infecting organism.

We are still in doubt as to whether tubercle is infectious in the ordinary sense, and cases of the disease having passed from person to person by "infection" are so rare as to leave us in doubt whether some error may not have vitiated the recorded case. On the other hand, it must be borne in mind that the onset of tuberculosis is very insidious and gradual, and is not attended with any striking phenomena like the onset of the eruptive fevers, so that the time of onset can never be determined. And, again, the disease is so common that when tubercle makes its appearance we can never say that the individual infected by it has not been exposed to infection.

Its undoubted relationship to overcrowding and bad ventilation seems to me a very strong argument in favor of its infective nature. Phthisis causes rather more than 10 per cent. of deaths in this country, and is by far the commonest of any cause of death. In any workshop where a considerable number of artisans are working together, it is highly improbable that there are not some who are in a state to infect others; and if the cubic space be small and the ventilation bad, the risks of infection are greatly increased.

The *bacillus tuberculosis* is one of those which readily form spores, which are to the bacillus itself very much what the seed of a plant is to a cutting. We know that seeds may be kept for very long periods without losing their power of germinating. In this the spore of the *bacillus tuberculosis* resembles a seed. It may be dried and lie dormant for a long time, but being raised with the dust of the room, and being inhaled into the lungs, we have every reason to think that such a spore is capable of infecting the individual who is unfortunate enough to inhale it. The bacilli can be cultivated outside the body, but they require a high temperature, equal to that of the blood (*i. e.*, 98° and upward to about 103° Fah.), so that we cannot assume that in this country there is any spontaneous growth of tubercle bacilli outside the body.

Dr. George Buchanan has shown that the death rate from tubercular disease has sensibly decreased in certain localities, where effectual sewerage works have been carried out. Why there should be this connection between sewerage and pulmonary consumption is not clear. The sewerage works, by removing filth from the neighborhood of dwellings, would be likely to improve the health of the dwellers and increase their power of resisting infection.

Again, a certain amount of definitely dangerous and infective matter coughed up from diseased lungs would find its way into the sewers, and thus be carried clean away from the neighborhood of the dwelling. The soil being made drier, and the air as a consequence of this drier also, the bacilli would be more likely to lose their vitality, although the spores would not be affected.

A putrid soil or a putrefying cesspool, although they would not probably serve as a cultivation medium for the *bacillus tuberculosis*, may serve to maintain their vitality and virulence.

Whatever may be the true explanation of the fact which has been pointed out by Dr. Buchanan, we shall all readily admit that tuberculosis does not stand alone as an instance of an infective disease, the deadliness of which is enhanced by filthy surroundings.

There is one fact in connection with tuberculosis which is difficult to explain by the theory of infection, and that is its undoubted hereditariness, for that it is a disease which runs in families in a remarkable way there can be no doubt. There is, it must be remembered, more than one infective disease which is communicated by the parent to the offspring, but that this is often the case in tuberculosis is rendered unlikely by the fact that the disease does not often show itself till some years after birth.

When dealing with Raulin's experiment, at the close of the last lecture, the experiment which showed the importance of almost infinitesimal ingredients in cultivating media, I took occasion to remark that a constitutional predisposition to this or that disease, such as scarlatina or tuberculosis, might mean that the blood and tissues contain some infinitesimal ingredient necessary for the growth of the organism which gave rise to the disease.

Again, may not the predisposition to consumption consist in the inheritance of a long, narrow chest, which is the typical characteristic of a consumptive race? The coughing power, and the power of the lung to expel catarrhal products, is below par in such persons, and this is especially the case at the apex, which is the seat of election for the commencement of tubercular disease. The secretions of the lung lodging at this point would serve as a fitting nidus for the growth of the bacillus. Given a person whose family history points to a predisposition to consumption, it has always seemed to me, speaking as the medical officer of a life insurance office, that in estimating the probability of the individual suffering from consumption, the point of most importance to look to is the shape of the chest.

I have gone rather fully into some of these details, because of the general belief that phthisis is a disease inseparable from certain climates, especially climates like our own, which are cold and damp. It will appear, however, that it is rather an accident, so to say, attendant upon living in such a climate—a climate which induces us to live in overcrowded dwellings, and to neglect the important considerations of cubic space and ventilation.

The following facts, culled from the works of Dr. Parkes and Professor De Chaumont, are not without interest.

The large death rate in the country from diseases of the respiratory organs Professor De Chaumont believes to be due to the breathing of impure air, a cause which affects all classes of the community—high, low, rich, or poor; and he gives an interesting diagram of the death rate from these diseases in the registration districts north of the Thames, which shows tolerably conclusively that the death rate is proportionate to the crowding, and also to the population gathered round any particular spot. That is to say, that overcrowding under all circumstances is a cause of respiratory disease, but that overcrowding in a large town is more harmful than in a comparatively small one.

During the years 1830–46, the mean mortality from phthisis in the army on home service amounted to 7·86 per 1,000 of strength, the highest mortality being among the Foot Guards, with whom it reached 11·35 per 1,000 of strength. This state of things attracted the attention of Sir Alexander Tulloch and Dr. Balfour, who pointed out that, in the Equitable Assurance Company at that time, the average mortality between the ages of 30 and 40, from all diseases of the lungs, amounted to 3·4 per 1,000. The army mortality from phthisis was, therefore, three times greater than necessary.

The large mortality from phthisis among this picked class of the population, a class picked for their high physical qualities, and leading a life which at first sight would seem typically healthy, naturally roused inquiry as to the cause.

That it was not due to climatic conditions seemed tolerably plain, for the mortality of our troops from the same cause appeared to be equally great at some foreign stations. Thus at Gibraltar, 41 per cent. of the total deaths among the troops were caused by phthisis in the years 1837–46, while in the year 1875, only 23 per cent. of the deaths were due to this cause. At Malta, we are told that in former years phthisis was the cause of 39 per cent. of the deaths, or nearly the same as at Gibraltar. Latterly, there have been fewer deaths at Malta. In the island of Jamaica, the deaths from phthisis in the years 1817–36 amounted to 7·5 per 1,000 of strength; while in 1859–66 the mortality from this cause had fallen to 1·42 per 1,000 of strength. In Trinidad, lung disease killed on an average 11·5 per 1,000 of strength between 1817 and 1836, while the mortality from this cause has now greatly diminished.

Turning from the warm stations of the Mediterranean, and the warm, equable climates of the West Indies, to the extremely severe climate of Canada, we notice in the first instance that Canada is reckoned to be exceptionally healthy; and further, we are told that—

"The amount of phthisis has always been smaller than in some stations, and regiments of the Guards proceeding from London to Canada have had on two occasions a marked diminution of phthisical disease. The comparatively small amount of phthisis is remarkable, as the troops have at times been very much crowded in barracks. They have now the same allowance of space (600 cubic feet)."

In the twenty years 1817–36, the deaths from phthisis were 4·22 per 1,000 of strength, whereas in 1859–65 they were but 1·67 per 1,000. This improvement in Canada has been coincident with a similar improvement at home. The reporters call attention to the fact that these Canadian returns show how little the tendency to phthisis is increased by extremes or sudden changes of temperature.

PHTHISIS IN INDIA, PER 1,000 OF STRENGTH.

	Died.	Invalided.
Bengal—		
1863–66	1·707	2·729
1867–70	1·752	3·636
Bombay—		
1863–66	1·526	3·280
1867–70	1·238	3·576
Madras—		
1863–66	1·458	3·656
1867–70	1·336	4·737

ARMY AT HOME. 1864–70.

	Died.	Invalided.
Household Cavalry	3·763	8·234
Cavalry of Line	1·416	4·025
Foot Guards	2·300	9·491
Infantry of Line	2·120	5·510

How regularly the cause of phthisis must be acting in India is seen, says Parkes ("Practical Hygiene," p. 683), in the fact that in the four years 1863–66, 74 men died from phthisis in the Bombay Presidency and 73 in the Madras Presidency, the mean number of troops being in each case almost precisely the same (12,119 and 12,512). For the next four years, with a smaller number of troops, 53 and 55 died in the two presidencies.

The table seems to me to show clearly that the immense range and variation of climates in which the troops serve in India have no effect whatever on the production of phthisis; and this inference is again strengthened by the fact that the mortality in Bengal from phthisis is almost precisely the same as in Canada.

A reference to the table will show that there is less phthisis in India than at home. There can be no doubt that the causes of phthisis are less active in India; and if these causes are not climatic, must the difference not be found in the larger breathing space and greater lateral separations men have in India?

Among the causes of phthisis the most potent seems to be overcrowding in dwellings and the breathing of an impure air.

In Parkes' "Hygiene" mention is made (p. 123) of two Austrian prisons.

(*a.*) Prison in the Leopoldstadt, in Vienna, in which in the years 1843–47 there died 378 prisoners out of a total of 4,280, and of these 220, or 51·4 per 1,000, died of phthisis.

(*b.*) In the well-ventilated House of Correction in the same city, in the years 1850–54, 43 prisoners died out of a total of 3,037, and of these 24, or 7·9 per 1,000, died of phthisis.

"The well-known fact of the great prevalence of phthisis in most of the European armies (French, Prussian, Russian, Belgian, English) can scarcely be accounted for in any other way than by supposing the vitiated atmosphere of the barrack room to be chiefly at fault." This was the conclusion arrived at by the sanitary commissioners for the army. This view is strengthened by the fact that the British soldier has suffered from phthisis in the most beautiful climates, and every variety of station, *i. e.*, Gibraltar, Malta, West Indies, etc.

The deaths from phthisis in the Royal Navy averaged (3 years) 2·6 per 1,000 of strength, and the invaliding to 3·9 per 1,000. This is attributed to the foulness of the air on board ship. The degree of overcrowding met with on board ship is often excessive, and, if we are to accept the figures and statements published by Dr. Rattray in the Proceedings of the Medico-Chirurgical Society, in 1872, it is a matter for surprise that health on board ship is ever possible.

Dr. Rattray's observations (which are quoted by Parkes) were made on board H.M.S. Bristol, used for training cadets.

The cubic space for the crew to sleep in varied from 105 to 222 cubic feet, and that for the cadets from 242 to 506 cubic feet, and as the result of 150 analyses of the air, the carbonic acid was found to vary between 4·2 to 33·71 volumes per 1,000.

From what we have been saying, it will be gathered that much of the disease which is usually attributed to the effect of tropical climate may be avoided. If municipal, domestic, and personal hygiene demand our careful attention in temperate climates, this necessity is increased a hundredfold as we advance into the tropics. We have seen how health may be maintained in Arctic regions in spite of the necessary neglect of what in this country we have come to regard as the indispensable rules of health. When the dweller in northern climates, who has learned the art of living in spite of cold, turns toward the tropics, he is apt to forget that to live in warm latitudes requires scarcely any art at all, and he often finds to his cost that the dwellings, the clothing, and the diet with which he has comforted himself in the north are hinderances to health and comfort in the tropics.

If the diet be moderated, if the clothing be adapted to the climate, if very ample cubic space be given in the houses, and, above all, if towns and dwellings be kept absolutely clean and sweet and free from every kind of decomposing filth, then we find that most of the diseases inherent to a tropical climate vanish.

MALARIA.

There is one great class of diseases, however, which are practically unavoidable, and which demand our attention.

These are the various ailments which are attributed to malaria, and which include the various forms of intermittent and remittent fevers, and some forms of dysentery. Malarious diseases are due to peculiar conditions of the soil, and in order to understand the question, a few observations on "soil" in general become necessary. We have previously alluded to the effect of soil on temperature, and to the power it has of absorbing and radiating the sun's heat. Soils are of

* Three lectures before the Society of Arts, London. From the Journal of the Society.

all degrees of porosity, between the solid rocks on the one hand and the loose sands and gravels on the other.

There is a general opinion that dry soils are more healthy than damp soils. Dryness or dampness of soil depend—(1) upon the amount of moisture brought to it; (2) upon the power of the soil to allow the wet to percolate; and (3) the configuration of the surface and the provisions for drainage.

All soils contain more or less organic matter, both animal and vegetable, as must be evident if we consider the constant additions to the surface, of dead leaves and vegetable *debris*, of animal excrement and animal remains. These may be washed into the soil by rains, or may be brought to it by rivers. Soils which, to the unaided eye, seem to be composed entirely of mineral matter contain, in reality, considerable quantities of organic matter. This is the case in sandy plains, at the mouths of great rivers, as in Holland and the Landes, and it is also the case in some rocks which are much weathered and fissured, and which allow water to soak into them.

There is always active life in soil, or the potentiality of active life under favorable circumstances. Not only are there such animals as earth worms, but even in the driest soils there are found bacteria, which only require a certain amount of moisture and heat to start them growing.

The soil of towns, especially such a town as Munich, whose sandy soil is riddled with cesspools, is often sodden with sewage, and has its pores stuffed with excremental *debris*, and often, no doubt, contains the germs of specific diseases, such as typhoid, cholera, or phthisis. The pores of the soil are full of air, and this air always contains a large proportion of carbonic acid, a sure sign that fermentative, putrefactive, or respiratory processes are going on in it.

The gases in the soil may be drawn into neighboring houses by the heat of the fires, and, in fact, coal gas escaping from a pipe in the street has, in this way, been drawn into a house with fatal results.

In like way unwholesome gases, generated by the putrefaction of an impure soil, may find their way into houses, and with the gases doubtless the micro-organisms upon which the putrefaction depends, and possibly specific micro-organisms as well.

There are many micro-organisms which only flourish under certain conditions. Not only must there be organic matter for them to prey upon, and moisture and warmth to allow of their manifesting vitality, but the access of air is also necessary. If the soil be completely permeated by water, or if it be actually dry, then many forms of bacterial life languish; but when soil water which has been high subsides, leaving the soil moist, and allowing full access of air, then bacterial life reaches a maximum, and we run great risk of zymotic disease. At least, so says Pettenkofer, who asserts that at Munich epidemics of typhoid and cholera occur with the recession of the subsoil water.

Of course, as the subsoil water gets low, the surface wells draw more and more upon the neighboring cesspools, and the state of the soil need only act indirectly through the water supply.

The close connection between subsoil water and zymotic disease has not been observed to any great extent in this country. The fact that phthisis diminishes as the soil becomes drier and less sewage sodden, a fact pointed out by Dr. George Buchanan, has a new interest now that tubercular disease has been found to be inseparably connected with a bacillus, and we seem to be brought within sight of a possible explanation of the connection between town drainage and a diminished death rate from phthisis.

The best and, in fact, the only way to purify the soil is to cultivate it; and while we ought to be most careful that the soil round our houses (and beneath them) does not get overcharged with organic matter, we ought at the same time, by judicious planting, to take care that such organic matter as there is is turned to its right use.

With regard to the production of malaria in a soil, all writers seem to be agreed that three things are necessary, viz., sufficient organic matter in the soil to undergo a fermentative or putrefactive change, and sufficient warmth and moisture to foster the process.

If the moisture be in excess (as when a marsh during winter is submerged), malaria ceases; and if the malarious soil be completely drained and dried, malaria ceases. It would seem to be necessary for the production of malaria that water should not be present in quantity too great to allow the access of air to the interstices of the soil.

Many marshy soils contain a very large amount of organic matter, and many other kinds of malarious soils, such as sandy deltas, contain more organic matter than at first sight appears likely, and many sandy malarious districts which appear dry have, in reality, a layer of water not far below the surface. In spite of facts which appeared at one time adverse to such a conclusion, the opinion is now generally held that for the production of malaria we must have a soil containing organic matter apt for decay and putrefaction, and a certain amount of warmth and moisture. These are the conditions essential for that bacterial growth upon which putrefactive, fermentative, and similar disorganizing processes depend. What is the nature of this malarial poison? In the first place, it may be carried by air or by water; secondly, it may be carried considerable distances, and may be wafted along a valley, up a ravine, or across a plain in the direction of the wind. This fact makes it unlikely that the poison can be a gas, for the law of diffusion and dispersion would soon render any gas practically harmless. Again, the behavior of the poison, and the history and symptoms of malarious disease, make it unlikely that the poison is gaseous, for our knowledge of gaseous poisons almost forbids us to believe that any gas could give rise to exacerbations and remissions lasting for months, or even years. There are certain other facts, such as the power of a belt of trees to filter the poison out of the air, and the difficulty which it apparently has of rising far above the level of the ground in still weather, which make it likely that the poison is particulate. Krebs and Crudeli assert that they have discovered the malarial poison in the form of a bacillus, the *bacillus malariæ*, which is found in the soil of the Roman Campagna. Although we can hardly believe that the poison can be anything but a microbe of some kind, the observations of these two savants, nevertheless, need confirmation.

Malaria is sometimes developed in other ways. The first turning up of a rich virgin soil is always a dangerous process in the tropics, and is very apt to be followed by an outbreak of malarious disease. It would seem as though the free admission of air to the interstices of the soil had the effect of starting that form of life on which malaria depends. Decaying vegetable matter, on a comparatively small scale, has occasionally given rise to malaria, and instances are recorded of the generation of malarious fevers from heaps of indigo plants being allowed to rot and decompose, and from heaps of decaying vegetables. Malarious fevers have also broken out on board ship from similar causes. Given the conditions of soil which give rise to malaria, its virulence seems to increase with increase of temperature.

The only way of combating malaria seems to be the drainage and cultivation of the soil. The more productive the land can be made, the less are the risks of malaria. In England malarious troubles have become rare, but if from any cause the land should go "out of cultivation," the political economist will have to take malaria into consideration in dealing with the results.

The cultivation of the land seems always to do good. The planting of the eucalyptus has been productive of good results in some places, and, at Sierra Leone, the growing of grass in the streets has been beneficial. In the course of centuries, possibly, many of the most deadly of the tropical foci of malaria may be subdued by the husbandman, but practically we have to regard malaria, at the present, as an unavoidable evil inherent to certain localities.

Occasionally malaria will develop in a place which has been previously healthy. This occurred in the island of Mauritius, some sixteen years ago, and a glance at the table showing the health of our troops in foreign stations at two different periods will give some idea of the effect of this scourge on the British soldier.

The Mauritian fever seems to have been caused by the clearing of forests, the upturning of virgin soil, the increased defilement of the ground by increase of population, and the constant draining down of both animal and vegetable filth into a loose soil of slight depth. Then, in 1866, came deficient rainfall with a fall in the subsoil water and the free admission of air to the interstices of the soil. The conditions being given, malaria broke out and still continues. Before 1866 there was no malarious disease in the island. Since then it has raged more or less continuously, and when the fever was at its height in 1867, quinine fetched as much as £40 per ounce.

MOUNTAIN CLIMATES.

A few words may be said as to the peculiarities of mountain climates, but this need not detain us long, since what has been previously said will have enabled us to anticipate what these peculiarities are. We will take, as an example, that district which is just now much visited by the British tourist and the British traveler, and which is doubtless well known to many here present—I mean Davos and the Engadin, in the canton of Grisons, Switzerland.

The health resorts in this district are between 5,000 and 6,000 feet above sea level. The barometer stands at about 25 inches instead of the average 30, which means that the atmosphere exerts a pressure of 12½ lb. on each square inch of the body, instead of 15 lb., which is the normal at sea level. As a consequence of this the blood vessels of the skin dilate, and the inhabitants are singularly ruddy and healthy looking. It is from the same cause, probably, that the capacity of the thorax increases, and the dwellers in this region are, as a rule, full chested.

The weight of the oxygen in a given volume of air is less than in the plains, and to this, as well as to the diminution of pressure, is due the fact that the new comer to this district feels short of breath, and the action of the heart and the respiration are both quickened at first. The body soon accommodates itself to altered circumstances, and in a few days the shortness of breath disappears, and pulse and respiration fall to their normal state. The temperature of the air is less than in the plains, the fall in temperature as we ascend being, on an average, about 1° Fahr. for each 300 feet.

The moisture in the air is slight, both absolutely and relatively, and the drying power of the air considerable. In consequence of the rarefaction of the air and the slight amount of moisture, the sun's rays penetrate it easily, and have a remarkable power of heating solid bodies exposed to them. Thus the temperature in the sun may be scorching, while the shade temperature is freezing or far below freezing.

The power of the sun's rays is often increased in these regions by being reflected off rocks and snow, so that it often happens, in the depth of winter, that even invalids can saunter in the sunshine without discomfort or danger. The middle of the day is hot, but before and after sunset the cold is very great. The cold at night, however, is often not so great on the hillside as it is in the valley; for the cold air, chilled by the icy mountain top, falls, by gravitation, to the lowest point, and settles in the valley.

The alterations of temperature are sudden, and the effect of the sun on the thin, mobile atmosphere of these mountain districts is remarkable. There are few sights more astonishing or more beautiful than to see the sun rise in these districts, or to see him make his first appearance after a period of cloudy, rainy weather. The somber valley, choked with woolly clouds, is cleared almost in an instant by the first ray of sunshine that falls into it. Solid masses of cloud are apparently licked up by the darting sunbeams, and peak and crag, glacier and tranquil lake, verdant alps and picturesque chalets, on the instant stand out clear and distinct, while the observer is as suddenly swathed in genial warmth, and is soon made to forget the cold and discomfort which characterize these regions when the sun forgets to shine.

The amount of rainfall and wind varies in accordance with aspect and local considerations. At great elevations there is a good chance of getting a pure air to breathe. If a town or village be perched on a mountain side, the filth and impurity will obey the laws of gravity, and flow away down the mountains to annoy those who live below, instead of breeding sickness at the spot where the filth is formed. It is, doubtless, the purity of the air which constitutes one of the most valuable elements of mountain climates.

The effects of these climates are seen in an increase of animal spirits, increase of appetite, increase of energy and power of muscular exertion. To enjoy a climate of this kind a fairly good constitution is necessary, and some power of taking physical exercise and withstanding cold.

A word of caution seems necessary, and it is this—that directly a health resort becomes the fashion, it is within measurable distance of ruin. Density of population brings with it its attendant evils, difficulties of water supply and drainage, accumulations of filth, and an atmosphere stuffed with microbes. The authorities at these places cannot be too careful to prevent the close packing of houses and the erection of barrack-like hotels without adequate curtilage.

For healthy tourists, who are constantly on the move, and who are out of doors all day, and who are strong enough to tolerate fresh air even in their bedrooms, the question of hotels is, after all, a minor matter. But to send a consumptive patient to spend twenty or twenty-two hours out of every twenty-four hours during the winter in a barrack filled with consumptives like himself is a proceeding which is more likely to do harm than good. The one thing a consumptive patient needs more than anything else is fresh air to breathe. An overcrowded hotel which smells of drains, dinners, and humanity is not an ideal spot in which the consumptive should seek health.

The facts which I have brought before you must lead to the conclusion that a large proportion of the disease, which is loosely attributed to "climate," is, in reality, due to a wanton neglect of sanitary rules.

Sanitary rules with regard to ventilation, cubic space, and the disposal of filth, rules which we find it so necessary to observe even in a temperature like ours, demand far more scrupulous observance in the tropics. The majority of diseases which are fatal to us in the tropics are in fact filth diseases, and, with the exception of malaria, there can be no doubt that much of the sickness and mortality of tropical countries is distinctly avoidable.

In order to give point to this assertion, I cannot do better than call attention to the West Coast of Africa, a district with a most evil reputation as regards health.

It will be profitable to glance at the causes of mortality in this dreaded region, and ascertain to what extent that mortality is inevitable. Sierra Leone has at present a population of about 37,000 and a garrison of some 500 black troops. There are mangrove swamps north and south of the town. The water supply is good. From 1817 to 1837 the mortality among the whole white population was about 17 per cent., and among the troops the army returns show that there were annually 2,978 admissions to hospital and 483 deaths per 1,000 strength. It thus appears that the military death rate at that period was not far from being three times as great as the civil death rate.

If we turn to the causes of this terrible sickness and mortality among the troops, we find that malaria was a great cause of sickness, but not a great cause of death, and that yellow fever and dysenteric disease were among the most fatal complaints. Yellow fever is an acute infective disease, which occurs especially in climates where the temperature ranges above 70° F., although it may drag on a languishing existence even in temperate climates like this. Recent researches show that yellow fever is not in any way connected with malaria, but that it is a tropical filth disease, and that the great causes of its localization are (according to Parkes) overcrowding and the accumulation of excremental matters round buildings:

"And here we find the explanation of its localization in the West Indian barracks in the olden times. Round every barracks there were cesspits, often open to sun and air. Grant that yellow fever was somehow or other introduced, and let us assume (which is highly probable) that the vomited and fæcal matters spread the disease, and it is evident why, in St. James' barracks, at Trinidad, and St. Ann's barracks, at Barbados, men were dying by dozens, while at a little distance there was no disease."

Again, with regard to dysentery, we find the opinion very strongly expressed that its chief causes are impure water and impure air, brought about by overcrowding and fæcal emanation. To these causes must be added injudicious feeding and drinking. The errors of diet which seem to predispose to dysentery are mainly the taking of food in an early stage of decomposition, and a diet of imperfect construction, and such as leads to a scorbutic habit. The dysentery which was so fatal to the troops on the West Coast of Africa was, we are told, chiefly scorbutic.

"The causes of this great mortality were simple enough. The station was looked upon as a place of punishment, and disorderly men, men sentenced for crimes, or whom it was wished to get rid of, were drafted to Sierra Leone. They were very much overcrowded in barracks, which were placed in the lower part of the town. They were fed largely on salt meat; and being, for the most part, men of desperate character, and without hope, they were highly intemperate, and led in all ways lives of utmost disorder. They considered themselves, in fact, under sentence of death, and did their best to rapidly carry out the sentence."

So frightful was the mortality on this dreaded West Coast, that the white troops were ultimately replaced by black troops from the West Indies, and it is estimated that the total white population of Sierra Leone, of late years, has not exceeded 200.

From what has been said, it is evident that much of the sickness on this coast is preventable, and, indeed, of late years the health of Europeans at this station has been much improved.

The housing and feeding of the troops has undergone marked improvement, and the growing of Bahama grass in the streets and round the houses is supposed to have ameliorated some of the climatic conditions.

In the four years 1863–66, we are told that eight non-commissioned officers (white) died on the West Coast, and of these eight, three died of liver disease, two from *delirium tremens*, two from fevers, and one from dysentery. It would be difficult to say which of these eight died from unavoidable climatic conditions.

Among the black troops serving at Sierra Leone and the adjacent stations, phthisis and lung diseases appear to be the most fatal disorders.

In the ten years 1861–70, the deaths were 22·49 per 1,000 of strength, and of these phthisis caused 7·05 per

1,000 of strength. In some years the deaths from phthisis were in greater proportion.

In 1862, phthisis killed 12·6 per 1,000, and pneumonia 9·46 per 1,000. In 1863, phthisis killed 9·3 per 1,000, and in 1867 tubercular disease killed per 1,000 of strength—17·71 in Sierra Leone, 15·87 at the Gambia, 12·58 at the Gold Coast and Lagos. In 1862, we are told, there were only five cases of intermittent and 18 of remittent fever (23 cases of malarious disease) among 317 negroes.

At Gambia, as at Sierra Leone, phthisis and lung diseases were the chief causes of death among the black troops, and the reason for this is to be found, probably, in the ill construction and bad ventilation of the barracks. Speaking of the West Coast generally, Dr. Parkes says:

"There is no doubt that attention to hygienic rules will do much to lessen the sickness and mortality of this dreaded climate. In fact, here, as elsewhere, men have been contented to lay their own misdeeds to the climate. Malaria has, of course, to be met by the constant use of quinine."

The other rules are summed up in the following quotation from Dr. Robert Clarke, who is a most competent judge of the climate of this coast:

"Good health may generally be enjoyed by judicious attention to a few simple rules. In the foremost rank should be put temperance, with regular and industrious habits. European residents are too often satisfied with wearing apparel suited to the climate, while they overlook the fact that exercise in the open air is as necessary for health here as elsewhere. Many of them likewise entertain an impression that the sun's rays are hurtful, whereas, in nine cases out of ten, the mischief is done, not by the sun's rays, but by personal habits.

"Feeling sadly the wearisome sameness of life on this part of the coast, recourse is too frequently had to stimulants, instead of resorting to inexhausting employments, the only safe and effective remedy against an evil fraught with such lamentable consequences. Europeans also bestow too little attention on ventilation, far more harm being done by close and impure air during the evening and night than is ever brought about by exposure to the night air. Much of the suffering is occasioned by overfeeding."

Nothing can show more conclusively the value of the labors of the sanitarians both at home and abroad than the subjoined table showing the sickness and mortality of British troops per 1,000 of strength, on home and foreign stations, and for two periods in 1861 and the decade 1871–80.

It will be observed that the mortality has been lessened at all stations save two, the Cape and Mauritius. The increased mortality of the Cape is accounted for by the Zulu campaigns, and that of the Mauritius by the appearance of malaria in the island.

HEALTH OF BRITISH TROOPS AT HOME AND ABROAD.

Per 1,000 of strength.

	1861.*		1871 to 1880.†	
	Annual admissions to hospital.	Mortality.	Annual admissions to hospital.	Mortality.
India	1,768	37	1,454·3	19·37
China	1,492	28	1,196·3	13·8
Ceylon	1,440	90	971·3	15·26
Bermuda	461	14	632·7	8·72
West Indies	1,002	18·5	913·6	11·02
Cape and St. Helena	950	11·0	899·2	39·96‡
Mauritius	998	12	1,834·7	17·13
Malta	772	11	857·1	9·77
Canada	644	8·2	667·9	6·64
Gibraltar	927	9·0	675·9	6·67
United Kingdom	1,035	9	917·5	7·95
On board ship	....	..	571·5	7·64

The facts which we have been considering in these three lectures, and the reflections which we have made, will, I hope, prevent us from being hasty in condemning the climate of any country or locality as "unhealthy." Healthiness and unhealthiness are to a great extent in our own keeping all the world over. "The pestilence which stalketh in darkness" does so mainly because our eyes are shut, and we have long been in the habit of blaspheming the unseen powers for "sending" us diseases which are clearly of home manufacture. Ignorance and filthiness have in times past turned many an earthly paradise into a plague spot. Let us hope that the dawn of better things is at hand, and that when those who plume themselves on being the enlightened sons of civilization take possession of some island of the tropics, the lines of Bishop Heber may be in no ways applicable, in which he tells us that—

"Every prospect pleases,
And only man is vile."

ALIMENTARY VALUE OF ALBUMINOUS SUBSTANCES.

AT a recent meeting of the Physiological Society, Berlin, Prof. Zuntz reported the results of the experiments, partly instituted in conjunction with Herr Potthast, respecting the alimentary values of various albuminous substances.

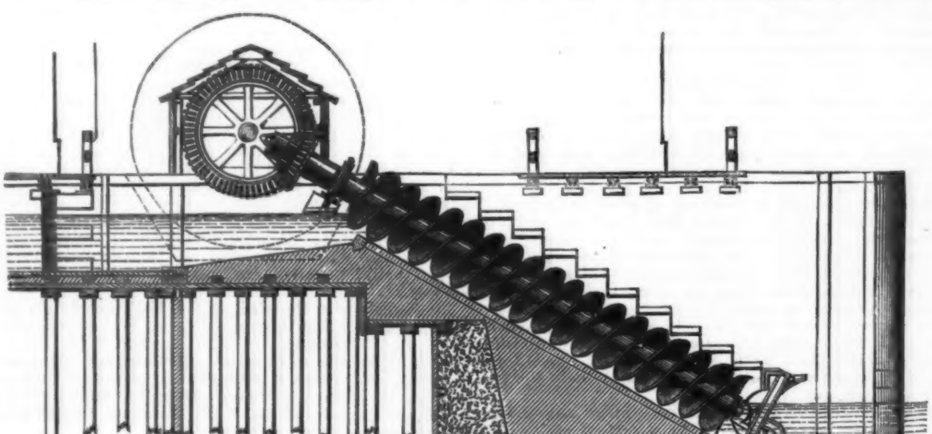
As a most important principle in conducting these experiments, the speaker laid down the maxim that the albuminous substance to be examined should not be administered in too large quantities. It was only with very small doses that the alimentary value of the different albuminous substances beside the same nourishment free of nitrogen could be determined. The dog was used for the purpose of the experiment. The proteine substances compared were: the albumen of lentils, that of lupines, that of gluten, and caseine. In the normal feeding, which regularly alternated with that of the albumen to be tested, the proteine of nourishment was imparted in the form of flesh meal. The result of the long and laborious experiments was that the alimentary value of the albumen of lentils and that of gluten were each found to be equivalent to that of flesh meal. That is to say, when to the food (which, apart from the additions to be specified, was the same in all the different cases) there were added equal quantities of albuminous nitrogen—in one case in the form of flesh meal, in another in the form of gluten, and in a third in the form of lentils—in each such case a quantity of nitrogen was developed, and therefore a quantity of albumen withdrawn from the nourishment, which was equal in all three. The albumen of lupines had a lower alimentary value than the albumen of flesh meal, seeing that from the lupines more albumen was decomposed than from the flesh meal. Finally, from caseine, less albumen was decomposed, and therefore more was absorbed by the body and utilized than in the case of any of the other albuminous classes.

By the means of this investigation two facts of general importance were established: First, it was ascertained that by changing the species of albumen employed by way of nourishment, a better utilization of the nutritive albumen was obtained, *i. e.*, less albumen was decomposed than if one and the same species of albumen were given for a long period; second, the paradoxical observation was made that during lactation, when the animal made use of a large quantity of albumen for the formation of milk, more of the albumen administered in the food passed away in waste than would have been the case in the same circumstances at a time of non-lactation.

The following explanation of these phenomena was given by the speaker. During lactation the animal used a certain quantity of albumen for the milk. The albumen of milk, as was known, was caseine. This caseine was not, however, administered in the food, but had first to be produced from the nutritive albumen (the various species of albumen being chemically different). Now, from the nutritive albumen only certain groups of molecules could be utilized for the formation of caseine. Far more albumen must therefore be decomposed than corresponded with the quantity of nitrogen in the caseine. Hence, therefore, the greater decomposition and the less utilization of the albumen of the nourishment. Nor was the albumen which the animal needed for incorporation with the body offered to it in the albumen of the nourishment, but the albumen taken by the body was built up from the constituents of the albumen of the nourishment. If only one kind of albumen was given to the animal, it required to decompose a large quantity in order to obtain sufficient constituents for the albumen appropriated by the body. If, on the other hand, different sorts of albumen were given in the food, then the animal decomposed on the whole a less percentage, seeing that in the differently composed albuminous substances it sooner found the different molecular groups which it needed for the building up of the albumen of the body.

THE ARCHIMEDEAN SCREW PUMP.

THESE pumps, although frequently used for lifting water from drains for the purpose of cleaning them out, and other similar purposes, have seldom been applied in this country for the permanent drainage of land. They derive their name from Archimedes, the Syracusan, who lived 287 B.C., and invented this machine, during his stay in Egypt, for draining and irrigating land. They were subsequently used by the Romans. The Dutch have used them very extensively in Holland for raising water for the drainage of the Polders.



DUTCH SCREW PUMP FOR DRAINAGE WORK.

The screw pump consists of three parts: A solid cylinder in the center, called the core, to which is attached one or more spiral screws, and sometimes an external case. The number of screws running round the core varies from one in the simplest machine to three or four in those of larger character. The ends of the core terminate in gudgeons which revolve in bearings, the lower one fixed under the water, and the upper on a beam spanning the delivery opening. As the efficiency of this machine is not affected by the speed at which it runs, it is suitable for being driven by steam, wind, or hand power. In small pumps a crank handle is attached to the upper part of the core, and on this a pole with an eye through the center, bushed with metal, is attached, the pole having cross handles at each end. One man works at the handle on the core, and one or more at each of the handles on the pole. It is reckoned that one man can raise in an hour at the rate of 1,738 cubic feet of water one foot high, the pump making 40 revolutions a minute. If worked by machinery, the pump is driven by a spur wheel at the top geared into a bevel wheel and shaft.

The water level on the inlet side may vary without affecting the efficiency of the pump, except so far as the increased weight is concerned, due to the greater length required to meet the variation. But any change in the level on the delivery side immediately affects the efficiency. These pumps are not therefore adapted for use where there is much change in the level of the water into which they discharge. The angle which the pump forms with the horizon when fixed varies according to the ideas of different constructors, but generally it may be taken that the most efficient position for the pump is when the angle of tilt is rather less than the spiral angle. Thus, for a machine having a spiral angle of 40 deg. the angle of tilt for the pump should be 30 deg. The spiral angle is the form which the screw assumes with reference to the core, and is the angle made by a tangent drawn to the spiral on the cylindrical core and a vertical line parallel to the axis of the cylinder. This angle varies from 30 deg. to 60 deg. The Romans usually made it 45 deg. In the most effective machines it varies between 30 deg. and 40 deg.

The discharging power of these pumps varies so much with the different circumstances under which they are worked, depending on the number of threads, the angle at which they are placed, the angle at which the pump works, and other matters, that it is difficult to give any precise formula for the quantity discharged. Upon pumps working under nearly similar conditions the discharge is as the cube of the diameter, and approximately it may be taken that, under favorable conditions, a pump 1 ft. in diameter will discharge 0·32 cubic foot of water for every revolution. The number of revolutions varies according to the kind of power applied and the size of the pump. Small pumps of about 1 ft. in diameter may be run at sixty revolutions a minute, the larger not reaching more than twenty. For drainage purposes it may be taken that these pumps can be run at from twenty to forty revolutions a minute. They have been used in Holland to lift the water 15 ft. Mr. Korevaer, a Dutch engineer, who has investigated the matter, places the limit of height at 14 ft., and the limit of discharge at 3,500 (98½ tons) cubic feet per minute. The ten screws erected at Katatbeh, in Egypt, discharged 137·5 tons a minute each, making five to six revolutions a minute. The screws were inclosed in iron cases, but were found unequal to the weight of water they had to carry, and were consequently removed. Where the amount of water to be lifted much exceeds the useful capacity of these pumps, it is customary to couple several together, all worked by the same engine. The useful effect of these pumps is about the same as scoop wheels, and varies, according to construction, from 50 to 85 per cent. of the power applied.

The Dutch screw pumps are constructed to work without an external casing, the wheel revolving in a semi-cylindrical trough of masonry. The weight of the water is thus borne on the masonry, and the screw is relieved of the strain. An example of one of these pumps is given.—*The Engineer.*

THE MODERN MARINE ENGINE AND BOILER.

AT a recent meeting of the London Association of Foremen Engineers and Draughtsmen, London, a paper was read on "The Modern Marine Engine and Boiler," by Mr. Walter Swanson, a chief engineer in the merchant service. Mr. Swanson stated that there was no better way of proving the immense improvements made in marine engines than a comparison of the fuel consumption in the early engines with that of the latest triple cylinder expansion engines. This result was very largely due to our better knowledge of boiler making, for although the advantages of high pressures and large expansion had long been known, it was only recently that reliable boilers could be produced to carry 150 lb. at sea. The present arrangement was considered very good, but he thought, with the improved appliances now in use, both for producing the material and working it into shape, we would soon hear of boilers capable of working at 400 lb. or 500 lb., and we would then require a different type of engine to utilize such a pressure. He considered in detail various types of marine boilers in use, giving the preference to the ordinary cylindrical wet bottomed boiler with smooth flues. He said corrugated furnaces were very good when new and clean, but when in regular work the corrugations filled up with scale, and he had

* Army Medical Report, quoted by Dr. Aitken ("Science and Practice of Medicine," second edition).
† Army Medical Report, 1861.
‡ Campaign.

seen some that had been a considerable time at sea with very little scale on the high parts, but the hollows filled up so that the top surface was nearly straight. He said the marine engine had more trying duties to perform than any other, as it must be readily and easily started and reversed, whatever the weight or horse power, and also be able to work continuously for very long periods without stoppage. He mentioned different types of engines, but preferred the triple cylinder three-crank engine, as combining these qualities with economy in cost of working better than any other. He considered in detail the principal parts of the engine, and mentioned some of the difficulties encountered by sea-going engineers, with suggestions for their removal. He gave a graphic description of the breaking of a screw shaft in stormy weather, and how they repaired it so as to be able to steam slowly to a port about 400 miles distant, and suggested that all shafts, before being put in, should be tested with a twisting strain at least twice as great as the maximum power of the engine, and should be retested after any serious accident. In speaking of condensers, he urged the adoption of a simpler way of securing the doors, as in the event of a leak at sea—no uncommon occurrence—it was no easy task to unscrew seventy or eighty bolts and secure the doors in heavy weather. The same remarks might apply to the air pump, which in many cases has no provision made for removing the valves or examining them without removing all the gear immediately above the cover of the pump. After describing different sorts of air pump valves, he eulogized Thompson's patent metallic valves as a boon to sea going engineers. He mentioned the necessity of a good, reliable reversing apparatus, as a ship ought to be stopped and made to move full speed astern in thirty seconds, and he had seen it done in fifteen seconds from the time of the engineer commencing to perform the evolution, by the use of patent reversing gear. Several of the members, including Messrs. Douglas, Coates, Stokes, Reid, and Heath, commented on the paper favorably. Mr. Douglas stated that his firm—Thorneycroft & Co.—had lately been perfecting a steam generator—he could not call it a boiler—which he thought would soon be heard of. They had put one in a torpedo boat, which kept steam up easily without forced draught, and some of the representatives of foreign governments present at the trials were so well satisfied that they had ordered several similar.

NEW TUNNEL UNDER THE THAMES RIVER, LONDON.

THE route extends from the city to the Swan at Stockwell. This distance is 3⅛ miles, and for the first half of it parliamentary powers have already been obtained. A bill for the remainder has passed the House of Commons, and unless something unforeseen should happen in the Lords, will become law this session. The up and down lines of the subway are absolutely distinct, each being carried in an iron tunnel. These two tunnels do not necessarily run side by side; they commence together at the terminal station in King William Street, but the down line falls more rapidly than the other, and before Swan Lane is reached, it has taken up a position exactly below the upper tunnel, and removed from it by some 5 feet. This arrangement is adopted because Swan Lane is too narrow to allow the two tunnels to run down it side by side without encroaching on the adjacent private property. At the bottom of Swan Lane the tunnels enter the river bed, the upper one 15 feet below the surface, and then the lower deviates a little to the right until the two are side by side. At the opposite bank of the river there is no convenient road for the subway to follow, and it therefore crosses under Hibernia Wharf into Borough High Street, after which the tunnels maintain their relative positions. In plan they are side by side, with about 5 feet intervening between them, but in section one is at a lower level than the other, in order to reduce the standing expenses at the station, by rendering it possible to work them entirely from one side. The passengers from the lower platform will pass under the other, and will ascend by a short ramp to the waiting room from which the lifts and staircases start. Thus the entire premises will be confined to one side of the street.

Each tunnel is 10 feet in diameter inside, and is formed of rings of segments bolted together by internal flanges. Each ring is 1 foot 7 inches long, and is composed of six equal segments and a short key segment with parallel ends (Fig. 6). The flanges are 3½ inches deep by 1¾ inches thick, and are bolted together by ¾ inch bolts. The circumferential joints are made by tarred rope and cement, and the longitudinal joints by pine strips. The method of erection is almost as simple as the tunnel itself. At the head of the subway, supposing a short length of tunnel to be already in place in the clay which underlies the River Thames, there is a steel shield consisting of a cylinder 6 feet long and of sufficient diameter to slide easily over the portion of the subway already bolted together. The forward end of this cylinder has a cutting edge, while about midway of its length there is a bulkhead having a door in it. Through this aperture the workmen remove a part of the clay in front, cutting out a small chamber considerably less in diameter than the shield. When this has been done, the shield is forced forward by six hydraulic rams fed by two hand pumps. The hydraulic cylinders are bolted to the shield, while the ram heads abut against the last ring of the completed tunnel. The cutting edge clears out an exact circle in the clay, forcing the material into the space prepared for its reception, from which it is dug out and loaded through the door into skeps for removal. As the shield moves forward it leaves at its rear an annular space, of about an inch, between the iron and the surrounding clay, and this is immediately filled with grouting to prevent any subsidence either of the tunnel or of the ground. The method by which this is accomplished is very ingenious, and is due to Mr. J. H. Greathead, the engineer in chief to the undertaking. The grouting, made of blue lias lime and water, is mixed in a wrought iron vessel (Fig. 5), provided with paddles which can be worked from the outside. The vessel is closed and compressed air, at a pressure of 30 lb. to 40 lb per square inch, is admitted to it, while the paddles are kept at work. By means of a hose pipe ending in a nozzle, the grouting is forced through holes left in the iron lining into the space between it and the clay, until the entire cavity is filled with a shell of cement which fits it exactly, and forms an impermeable coat round the subway, protecting it from moisture and oxidation. After the shield has been moved forward a ring of segments is bolted in, the rate of progress being about 10 feet in twenty-four hours.

The works are being actively pushed on, and already one tunnel is completed from the north to the south side of the Thames, and the second is following it. The plan of operations shows the same economy and respect for public convenience which marks the entire scheme. No street surface has been taken to form a contractor's yard, but in place of this a stage has, by the permission of the Thames Conservancy, been erected in the river behind the Old Swan Pier, and from this a shaft has been sunk through the river bed to the requisite depth. On the stage there is erected a crane which lifts the skeps of clay, and delivers them on to a small tramway, along which they run to deliver their contents into barges; there is also a fan and an air compressor driven by a small engine, and a wooden office, this constituting the entire present overhead plant of this great undertaking. The shaft is 13 ft. in diameter, and is made of cast iron rings, each cast in one piece. The thickness of metal is 1½ in., except at the bottom, where it is thickened on the inside, contrary to usual practice, to form a cutting edge. This shaft was erected in the usual manner by removing the material from inside it with a grab, and descends nearly to the crown of the upper tunnel. From this point it is carried down in brickwork, mouthings for the two subways being made in it of the same material. There is no water to be dealt with, the tunnels being absolutely tight, and the work of extension goes most smoothly. Indeed, it is impossible to realize, except by personal inspection, what a simple matter tunneling in clay has become by the method employed by Mr. Greathead. This plan, however, is by no means restricted to clay, but can be modified to suit mud, sand, gravel, and rock.

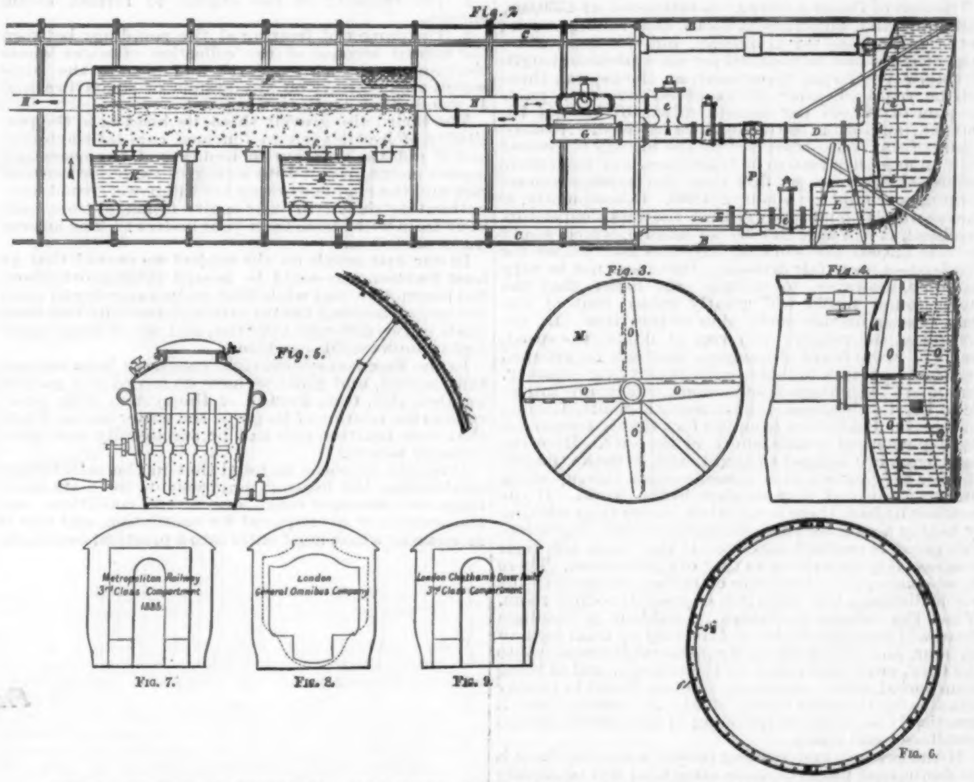


FIG. 7. FIG. 8. FIG. 9. FIG. 6.

THE NEW TUNNEL UNDER THE THAMES RIVER, LONDON.

When the ground is so soft that it can be washed away, the method of removal by pick and spade is abandoned, and in place of this a constant circulation of water is maintained at the outer face of the shield by means of a pump. In the first instance, before the distance from the shaft becomes too great, a very simple plant will suffice. Two pipes, one bent over to dip into the river, are led down the shaft and along the tunnel to the shield, through which they pass, the one near the top and the other near the bottom. Water is drawn by a circulating pump from the river and forced out through the upper pipe against the bank of mud or sand which presses against the face of the bulkhead in the shield. The pressure thus created finds an outlet at the lower pipe, along which the current flows back to the shaft, carrying the solid material with it into the river or barge moored alongside the shaft. The two columns of water balance each other, and all the work required of the pump is to overcome the friction in the pipes and at the working face. As the work proceeds, the friction, however, becomes a very important item, and other arrangements have to be adopted. One form of these is illustrated in Fig. 2. In this the entire circulation takes place between the face and a closed tank, F, which is maintained under a pressure equal to that existing at the face. In the first instance this tank is filled with water which is forced through the bulkhead of the shield, B, in several streams at *d d d*. The action of the jets is aided by the bars, *a a*, which are worked by hand or mechanical power to attack the bank, and to cause the debris to flow with the current through the receptacle, L, and along the pipe, E, into the tank at the rear end. Should there be any bowlders in the ground, they will become lodged at L, and can be broken, by means of the bars, *t t*, into pieces capable of passing along the pipe. If a bowlder should prove refractory to this treatment, an air lock would be erected in the shield or tunnel, and the forward end filled with compressed air until the cover of the receptacle could be removed safely and the bowlder extracted bodily. In many cases, however, no such difficulty could be met, and the process of pumping would suffice to remove the whole of the debris and deposit it in the tank. As sand or gravel accumulated it would displace an equal quantity of water from the tank, which must have an outlet to permit the shield to move forward. For this purpose, the pipe, H, is carried backward and up the shaft, and through this the surplus will escape. When the tank is to be emptied, the valves, *e e e*, are closed to cut off all external pressure, and tubs, K K, filled with water are brought under the outlets, *f, f*. These dip into the tubs, and when they are opened an interchange of the contents of the vessels, F and K, takes place. The sand descends into the tubs while the water rises to take its place, the arrangement being exceedingly neat and ingenious. To clear out the pipes, the entire current can be sent from the pipe, D, direct to the pipe, E, through the connection, P.

Clay, mud, sand, gravel, and bowlders do not exhaust, however, the list of substances to be met with in tunneling. There still remains rock to be dealt with, and for this Mr. Greathead had designed the appliance shown in Figs. 3 and 4. Through the face of the shield, A, there projects a shaft carrying a two armed tool holder, O, fitted with steel tools. The shaft is driven by a compressed air motor, and as long as the tools are in a satisfactory condition, it is protruded so far through the shield that the holder stands in the position shown in dotted lines in Fig. 4, and bores its way through the rock. When the tools become blunted and require renewal, the holder is set horizontally (Fig. 3) and is drawn back under the hood, M. It is then set vertically, and the space under the hood is filled with compressed air to permit of a manhole being opened in the shield, and a man entering the chamber. After the tools on one arm of the holder have been removed, the shaft is rotated through 180°, and the other set are renewed. The man then retires, closes the manhole, the shaft is pushed out again, and the work proceeds, the fragments of rock being swept back by the current.

In their bill the company disclaim the use of steam locomotives on their lines, reserving the right to employ any other method of haulage. It is their intention to use rope traction, a method of haulage which is peculiarly well suited to a subway, as it is practically independent of gradients, and enables a uniform speed to be maintained at all parts of the line. The trains will be drawn by endless wire ropes running up one tunnel and down the other from a central motive power station near the Elephant and Castle. There will be two wire ropes; one will start from the engine house, proceed to the City along the "up" and return along the "down" line, while the other will make a similar circuit in the opposite direction to and from Stockwell. The leading carriage of each train will be connected to the rope by a gripper, that is, by a jaw which can be closed upon the rope by a screw or lever when it is desired to start, and can be relaxed as a station is approached. We have already illustrated many such grippers among the plants for cable traction described in the articles on cable tramways which have appeared in our columns from the pen of Mr. Bucknall Smith. The rope will travel in the first instance at the rate of ten miles an hour, and the average speed of the trains will be about nine miles per hour, including stoppages at four intermediate stations. The vehicles will resemble tram cars, but will have considerably more head room, while their width, which will exceed by 18 inches that of the second class carriages on the Metropolitan Railway, will render them very comfortable and convenient for entrance and exit. Figs. 7, 8, and 9 show the relative sizes of the subway cars, the General Omnibus Company's vehicles, and the second class carriages of the Metropolitan and London, Chatham, and Dover Railways. They will carry a double set of brakes to give perfect security. There is, however, only one spot in which the gradients are steep enough to be of importance; that is between the City station and the

river, where the up line rises at 1 in 30, and the down line falls at 1 in 15. At other parts the line is practically level. As the stations are approached, the ropes will be released from the grippers and the brakes applied, the operation being very rapid, owing to the light weight of the vehicles as compared with railway stock. A train will weigh about 20 tons gross, against 165 on the Metropolitan Railway, and of this 7 tons, or 35 per cent., will be passengers, against 15 per cent. on the railway. After the passengers have alighted, an operation not requiring more than twenty seconds, every carriage having separate inlet and outlet doors, the train will get away very rapidly, as the motive power will not have to start from a state of rest, and will be capable of exerting a greater tractive power, in proportion to the weight of the train, than ordinary locomotives. At the terminal stations both lines will converge on to a single track, and the trains will scarcely be detained longer than at the intermediate stations. The driver will merely move from one end of the train to the other, and will engage the leading gripper with the return rope. He will then be ready to start out again without the delay which would be entailed if a locomotive had to be moved out of a siding and coupled to the train, and without causing a block to the two-minute service it is intended to run during the busy parts of the day.

The ventilation of the subway is a matter which may be safely left to take care of itself without misgiving, and without any fear of "blowholes" being opened in the streets. As there are to be no locomotives, the greatest cause of foul air, particularly of sulphurous acid, will be absent, while the constant direction of the traffic in each tunnel will convert the trains into a series of pistons which will maintain an active circulation of air. Even in the large tunnels of the district railway a train pushes an immense quantity of air before it, and produces a partial vacuum behind it. Unfortunately, the opposite services greatly neutralize each other's good effects.

The cost of the new subway is estimated at £550,000, including land, buildings, stations, and rolling stock; not a great sum for a railway, but yet many times larger than would be required for an equivalent length of tramway. To pay 5 per cent. on the capital, there will be required, after all expenses have been paid, the sum of £27,000 per annum, raised by fares of 1d. and 2d., according to the distance traveled. Already a part of the route traversed by the subway is covered with an extensive system of tram lines, and from their published accounts we find that the average annual earnings per mile are about £14,000. Consequently, if the subway is no more successful than its competitors overhead, it will take £46,500 per annum, which would provide £19,000 for working expenses and £27,000 for dividend—a very fair division. One need not be very sanguine, however, to indulge the belief that the underground traffic will greatly exceed that of the tram cars, as on the north side of the river. In the first place, the vehicles will run at double the speed, and will make fewer stoppages; they can be grouped together in trains to increase their carrying capacity. But apart from these comparisons, which are intrinsic to the two systems, the tramway in South London has special disabilities from the fact that it terminates three-quarters of a mile short of the city. Here the passengers are obliged to alight, and to make the rest of their way on foot in a miscellaneous throng along the most crowded thoroughfare in the world. If the weather be bad, there is no other choice than walking or taking a cab, for the omnibuses are full long before this point is reached, and even if they were not, their progress is quite as slow as that of a pedestrian. There is, of course, the alternative of taking an omnibus the whole distance, but often it is impossible to find room. When the subway is finished, a resident in Clapham Road will have the choice of traveling by tram for half an hour, and then walking a considerable distance into the City, or of descending to the subway, and of being transported right into King William Street in twenty minutes for the same outlay of 2d. At present there is practically no means of traveling in this district besides omnibuses and trams.

If the present undertaking proves a success, there is no doubt that projects of the same kind will be rapidly set on foot for other parts of London, and that there will result a great improvement in our means of communication. This would prove a boon to the shopkeepers, as it would enable people who cannot afford cabs to make the journey to Oxford Street and Tottenham Court Road without enduring the purgatory of half an hour's ride in an omnibus. If ladies—for it is they who do the greater part of the shopping—could be carried rapidly from shop to shop, it would do more to arrest the growing supremacy of co-operative stores than any agitation the retailers can raise.

In conclusion, we may state that the engineer in chief to the undertaking is Mr. J. H. Greathead, of 8 Victoria Chambers, Westminster; the resident engineer, Mr. W. J. McCleary; while the contractor is Mr. Edmund Gabbutt, of Liverpool.—*Engineering.*

[Continued from SUPPLEMENT, No. 588, page 9392.]

IMPROVED METHODS OF HEATING RAILWAY TRAINS.

By C. POWELL KARR, C.E., Consulting Architect, New York.

II.

THE TWOFOLD METHOD—CONTINUOUS OR INDEPENDENT.

THE practicability of heating a train by steam from the locomotive or from a separate car is now generally admitted. The rapid growth of ideas in this respect is nowhere better shown than in the two reports issued by the New York Railroad Commission. In the former grave doubts were cast upon the feasibility of heating a train from the locomotive, while the latter report took decided ground in favor of steam heating.

It reached the conclusion that all the improvements thus far proposed in the car stove to a greater or less extent simply reduce the percentage of risk, but not its elimination; that there seemed to be no way absolutely to get rid of the dangers incident to the car stove.

The safety heaters cost from $200 to $300 per car, and it appeared to the board that the rapid strides now being made toward heating from the locomotive will soon force the substitution of that method as the safest and cheapest, and a large expenditure incurred in a mistaken direction averted.

Since the tendency of invention and of experiments by railroads seems to be toward heating from the locomotive, and since that method promises greater security to the traveling public, it was thought best to urge all efforts to that end, and to discountenance independent methods of steam or hot air heating.

Having determined, therefore, that it is best to endeavor to abolish car stoves and heaters, and to require that steam or hot air shall be used from the locomotive, or from an independent car, the question of how far legislation ought to go at the present time naturally occurred to them. The art of steam locomotive heating has been practically tested to an extent that warranted them in saying that under all ordinary circumstances it can be adopted by railroads upon

FIG. 3.

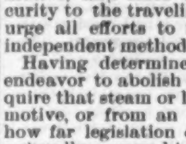
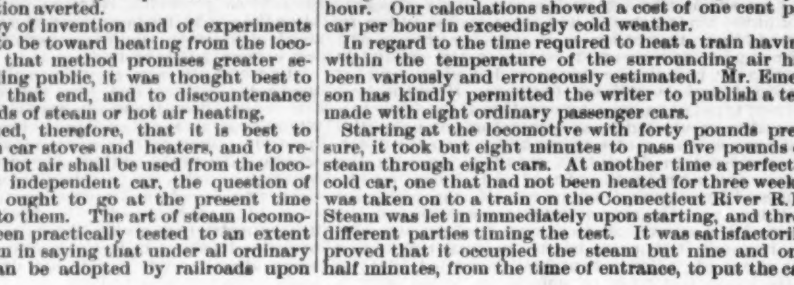


FIG. 1.



trains of from three to seven cars without serious apprehensions of failure from the following causes:

1. The inability of the engine to furnish steam enough.

2. The danger of freezing at the couplings between the cars on account of the collection of water where the pipes settle below a level, and also in the traps which are necessary on any system of steam heating. It was dubious on the latter point.

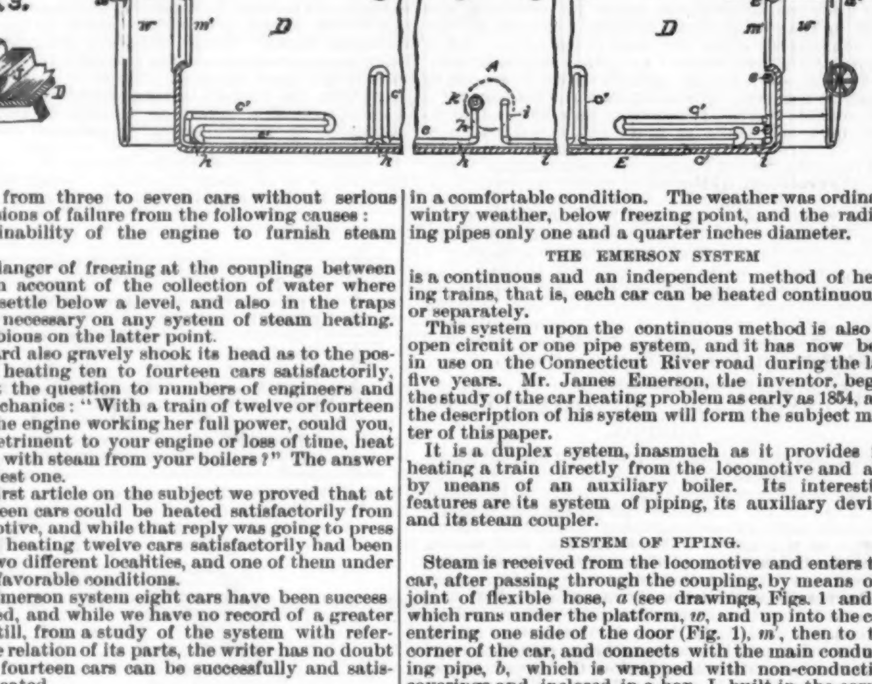
The board also gravely shook its head as to the possibility of heating ten to fourteen cars satisfactorily, and it put the question to numbers of engineers and master mechanics: "With a train of twelve or fourteen cars and the engine working her full power, could you, without detriment to your engine or loss of time, heat your train with steam from your boilers?" The answer was a modest one.

In our first article on the subject we proved that at least fourteen cars could be heated satisfactorily from the locomotive, and while that reply was going to press the test of heating twelve cars satisfactorily had been made in two different localities, and one of them under highly unfavorable conditions.

In the Emerson system eight cars have been successfully heated, and while we have no record of a greater number, still, from a study of the system with reference to the relation of its parts, the writer has no doubt that even fourteen cars can be successfully and satisfactorily heated.

It should be borne in mind that in the calculations establishing the heating requirements for a standard large size passenger coach, one of the conditions was the amount of air required for ventilation, and this is an element which must enter into a practical considera-

FIG. 2.



tion of the subject. Were the air to be changed in a car but once an hour, instead of four times an hour, it would make a difference of nearly ten per cent. in the condensation per car per hour.

Again, most of the cars upon which the various systems of steam heating have been tried are the ordinary fifty-six foot passenger coaches, with about 290 cubic feet of space less to heat than the standard car, and a much smaller area of glass surface, so that taking these changes into consideration, and under the same temperatures, the Emerson system ought to approximate closely to five gallons of water condensed per car per hour, for a short train of five to eight cars, but with the train increased to fourteen cars the condensation would run up appreciably close to our first calculations. Indeed, so close have these figures come to actual results, that a reliable steam heating engineer who has been devoting his time for the last five years to the problem of car heating, informed the writer that his results by measurement, with coal at $2 per ton, bring the cost up to nine tenths of a cent per car per hour. Our calculations showed a cost of one cent per car per hour in exceedingly cold weather.

In regard to the time required to heat a train having within the temperature of the surrounding air has been variously and erroneously estimated. Mr. Emerson has kindly permitted the writer to publish a test made with eight ordinary passenger cars.

Starting at the locomotive with forty pounds pressure, it took but eight minutes to pass five pounds of steam through eight cars. At another time a perfectly cold car, one that had not been heated for three weeks, was taken on to a train on the Connecticut River R.R. Steam was let in immediately upon starting, and three different parties timing the test. It was satisfactorily proved that it occupied the steam but nine and one half minutes, from the time of entrance, to put the car in a comfortable condition. The weather was ordinary wintry weather, below freezing point, and the radiating pipes only one and a quarter inches diameter.

THE EMERSON SYSTEM

is a continuous and an independent method of heating trains, that is, each car can be heated continuously or separately.

This system upon the continuous method is also an open circuit or one pipe system, and it has now been in use on the Connecticut River road during the last five years. Mr. James Emerson, the inventor, began the study of the car heating problem as early as 1854, and the description of his system will form the subject matter of this paper.

It is a duplex system, inasmuch as it provides for heating a train directly from the locomotive and also by means of an auxiliary boiler. Its interesting features are its system of piping, its auxiliary device, and its steam coupler.

SYSTEM OF PIPING.

Steam is received from the locomotive and enters the car, after passing through the coupling, by means of a joint of flexible hose, *a* (see drawings, Figs. 1 and 2), which runs under the platform, *w*, and up into the car, entering one side of the door (Fig. 1), *m'*, then to the corner of the car, and connects with the main conducting pipe, *b*, which is wrapped with non-conducting coverings and inclosed in a box, J, built in the corner formed by the junction of the side, E, and floor, D, of the car, as shown in Fig. 3. This is a very superior method of passing the main supply pipe through the car, as it avoids a great loss of heat by convection, the air in the box being so confined that motion of its particles among themselves is impossible. The conducting pipe, *b*, runs from one end of the car to the other, and each end is provided with suitable connections for taking or delivering steam. The pipes, *a'*, are provided with stop cocks, so as to regulate the supply of steam to the pipe, *b*. The circulating pipes are indicated by *c*. They run along the side of the car above pipe, *b*, and loops are arranged in position under the seats for local trains; for through long trains their use has been abandoned, the frictional resistances offered by the elbows being too great to overcome by low-pressure steam.

The drawings show the pipe and coils, *c*, connected with the pipe, *b*, at one end by a branch, *z*, having a stop valve, 6. A stop valve, 4, is placed in the pipe, *c*, between valve, 6, and the loops and pipes beyond valve, 4. At the other end of the car the pipe, *c*, is connected directly with the pipe, *b*, a stop valve, 5, being placed in a pipe, *c*, near the latter. The difference in the methods pursued in connecting the pipes, *b* and *c*, at

the two ends is caused by the additional pipe connection, e, which carries steam over the car door, m', to the pipes, c', on the opposite side of the car. The two sections of pipes, e e, one each side of the door, m', in Fig. 1, are about on lines, x x, Fig. 2.

The drip pipe, d, conducts the hot water of condensation from pipes, c, to the boiler. The connections of the pipe, e, are shown in the drawings; h is also a drip or return pipe which conducts the water of condensation which accumulates in the pipes and coils, c', into the boiler, A. To accomplish this purpose, the pipe, h, passes through the head of the boiler, A, and extends nearly to the bottom, so that its lower end may be submerged constantly in water; see Fig. 2.

The pipes, b, are the supply mains, in which steam is maintained at a certain temperature. The condensed steam which may collect in the mains can be drawn from them by opening the cocks, 5 and d', when it will pass through pipe, d, to the boiler, and keep the latter filled with hot water ready for emergencies, in which it may be required to keep the train warm independent of the supply of steam from the locomotive.

In first heating up the pipes and loops, c, which are connected with the pipe, b, valve 2 is opened, also valves 5 and 4, when the steam will flow into the pipes and loops, and any water of condensation formed will escape through the pipe, d, to the boiler upon opening the valve, d'. In cold weather, when it is necessary to heat a car quickly or to maintain a higher temperature in the car, condensation will increase more rapidly. Valve 4 should be closed, valve 6 opened, thus sending the steam over the door through the pipe, e, and into the pipes and loops, c. The water of condensation then enters the boiler, A, through the pipe, h. To keep the water in the boiler at a certain level, and to dispose of its surplus, the overflow cock, 7, is kept partly open.

THE AUXILIARY BOILER

is designed to supply the means of heating each car separately, and maintaining a comfortable temperature within the car when the supply of steam for some reasón happens to be shut off from the locomotive.

The boiler, A, is of sheet iron, riveted in the usual way, and suspended under the car floor. It is provided with a heating device, B, shown in the drawings in the form of a circular lamp, provided with a suitable supply of wick tubes, so as to quickly convert the water in the boiler into steam. The reservoir, K, is attached to the end of a vertical pipe, and a stop cock connection permits of discharging the hot water of the reservoir into the boiler, thus shortening the time of getting up steam.

When it is known that a car is to be detached from a train which it is desired to keep warm, the pipes, c and c', and the boiler, A, are filled with live steam from the locomotive at any pressure desired. The fire under the boiler is lighted until the return of the locomotive, and then it is extinguished, in order that there may be no fire on the car while the train is in motion. When only a moderate temperature is required in the car, valves 6 and 4 are closed and the steam circulation from the boiler through the pipe, i, into the pipes, c', is confined to the latter, and the condensation is returned to the boiler through the pipe, h, and but a moderate waste of water occurs, and that is replaced by drawing an equal amount from reservoir, K. When more heat is required, the steam from the boiler is permitted to pass through the pipe, e, and upon opening the valve, 6, the steam passes into pipe, b, and through valve 5. As valve 3 is shut the condensation escapes through d to the boiler.

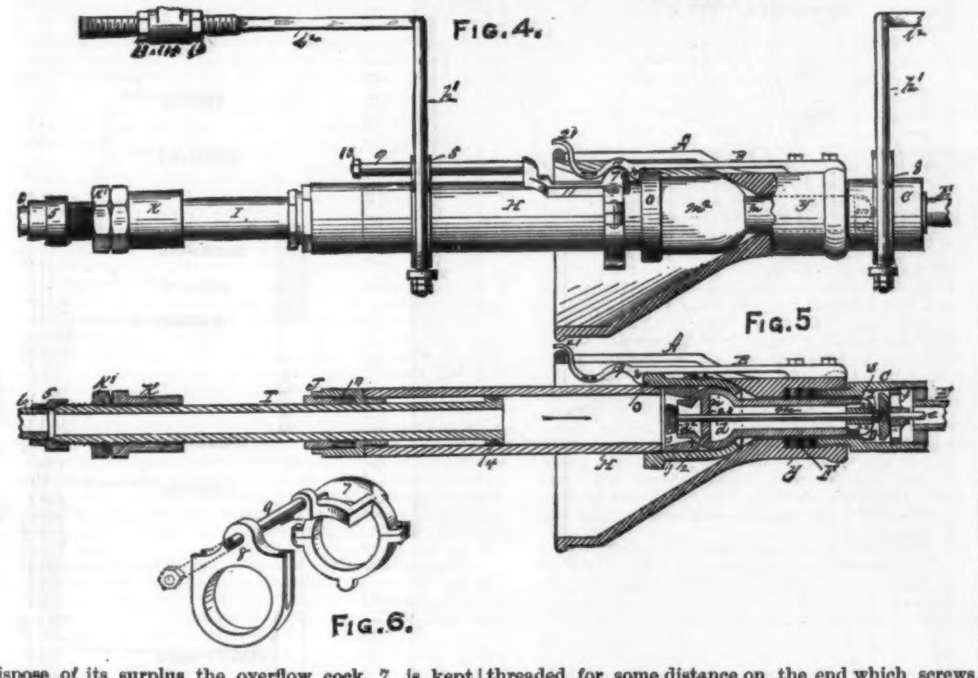
THE COUPLER.

As will be seen from the drawings Figs. 4 and 5, the coupler is a self-connecting and disconnecting device. The end of one car is provided with a receiving connection, and the end of an adjoining car is provided with an entering connection. The two connections are shown locked together in Figs. 4 and 5, and in a position to allow steam to pass through them. The receiving connection is constructed with a large open mouth, A, having a tubular extension, y, to which is screw-connected a back pressure valve case, C. Between the inner end of the case and a shoulder around the interior of the part, y, is placed a series of elastic packing rings, F, with metallic rings between them as indicated in the drawing, Fig. 5, by three black bands in section. The inner edges of these elastic rings project into the passage in the tubular part, y, into which the valve case, m, is forced. This valve case, m, extends in tubular form beyond the ball joint into the valve case, C, and has a plug screwed into its end with perforations, 22-22, and a central valve stem passage. The valve, d^3, with its stem, d, is adjusted so as to seat itself in the end of the case, m. The spindle, d, of the valve, d^3, has a head outside of the plug, through which it passes, which serves to govern the movement of the valve from its seat, and passes through a supporting cross bar, 23, by which the valve is supported in a central position and is permitted with its stem to have a swaying motion. The entering connection of the parts of the valve is supported in the yoke, 8, with which the arm, h', is connected. Through this yoke a rod, 9, passes with one of its ends secured to a tripping ring, 7, on pipe, H, and the other is provided with a nut, 10, adjustable on the rod, 9. D is a back pressure valve, with a spindle, e, and supported in the case, C, by a perforated disk, f, which has a hub through which the spindle passes; the valve is seated against the shoulder, s, in the case, C, and can be moved from its seat by the entering connection; see Fig. 5.

The spring, B, is bolted at one end to the part, y, and extends into a slot in the mouth, A, with a handle, 21, upon its free end. This handle reaches above the slot, and consists of two reversely curved parts, 19 and 20, and a catch block, r.

The steam pipe, E, is connected to the valve case, C, and conveys the steam from the latter to the pipes in the car. The yoke, 8, is fitted on to the exterior of the case, c, and is connected with the arm, h^1, and rod, i^3, by which the receiving head is supported.

The male half of the coupler is secured to the end of the steam pipe, 6. The latter conveys steam from the pipes in the car to which it is attached by the coupling, 5, and this is made with an expansion telescopic joint, consisting of the pipes, H and I. The latter is screw threaded for some distance on the end which screws into the coupling, and a stop nut, K, and a set nut, K^1, are placed upon it.



The end of pipe, I, within pipe, H, is provided with a collar and its usual packing. J is a stuffing box, secured to the end of the pipe, H. The packing is shown at 4, Fig. 5.

By the nut, k, the movement of the end of pipe, H, toward the latter is regulated; and when the cars move toward and from each other the pipe, I, telescopes into the pipe, H, and this movement receives and compensates for the jar and plunging of the train.

At the end of the pipe, H, entering the mouth, A, the ball joint, m^2, is secured. The ball shaped end of the valve case, m, is fitted into the ring, o, and ground to make a steam tight ball joint by which a free lateral motion is obtained. The rings, 3, and an elastic washer, 2, are inserted in the case, m^2, between the end of pipe, H, and the ball shaped part of case, m, the washer bearing against the ball and keeping the latter to its bearing in the receptacle, m^2.

THE ACTION OF COUPLING.

When the cars meet, the two halves of the coupler are brought to the positions shown in Figs. 4 and 5, the spring, B, is caught by the ring, o, upon the catch block, r, by which the parts are held together. The motion of the car carries the entering half in and causes the yoke, 8, to move against the end of the arm, 11, on the ring, 7, Fig. 4, and takes it under the curved arm of spring, B.

When the head of the valve spindle, d, strikes valve, D, the latter is driven away from its seat against the perforated disk, f, and by it the spindle, d, and valve, d^3, are moved in opposite directions, and both valves, d^3 and D, are moved away from their seats, letting steam flow in the direction indicated by the arrow in Fig. 5, directly through the valve cases, m and C, into pipe, E, and to the next car.

When the cars are separated, the pipe, H, is drawn through its yoke, 8, until the latter is brought against the nut, 10, when the ring, 7, is drawn back, lifting the spring, B, and disengaging the catch, r, from the ring, o, and permitting the two parts of the coupler to be drawn apart. The valve, d^3, is then closed by steam pressure, and the valve, D, by back steam pressure from the car with which the pipe, E, is connected. The packing rings, F, serve to make the case, m, enter tightly into the part, y, and prevent the steam from blowing backward.

This automatic arrangement for closing the valves is so simple in its mechanism as to not easily get out of order, and so admirable in its purpose as to be worthy of more than a passing description. Most of the steam heating devices are arranged to blow off the back pressure at the couplers, but in this system no possible scalding of the brakeman's hands is attainable. Apparently the real division in Fig. 1, between the two parts of the coupler, is at the edge of the ring or collar, O. Its real line of division however follows an irregular line about the ball bearing, and seen more accurately in Fig. 5, in cross section. Fig. 6 shows a detail view of the yoke, 8, and the ring, 7. The rod, I^3, connected with the yoke, 8, secures the coupler, each respectively to its end of the car. By unscrewing the nut, 10, the coupler can be reversed, so as to do away with the necessity of having two sets at each end, the sets being separated and changed end for end.

In regard to the management of the couplers, the rule is to leave the couplings and valves open at the end of each trip, so that when steam from the locomotive enters the heating pipes it continues through until it issues from the drip at the bottom of the auxiliary boiler. The valve is then closed, the open pet cock at the top furnishing vent for circulation, while the condensation fills the boiler with hot water ready to be converted into steam by simply lighting the prepared fuel in the fire box of the boiler. In this way forty pounds of steam have been raised in ten minutes after lighting the fire. The inlet valve from the supply pipe is closed when heating in this way, and also the pet cock at the top of the boiler. The heating by the continuous circulation system thus renders that car independent of the locomotive. At the same time, steam from the locomotive may be sent past that car to another in the rear. While heating from the auxiliary boiler the fire must be kept up, consequently the car often becomes too hot, unless the steam is shut from the pipe leading to the heating circulation. Then, as the pressure in the boiler would become so great as to blow off, causing a loss of water, a valve is opened in a pipe leading from the small boiler to the left, as shown, which connects with the piping on top of the car, where the steam condenses and returns as water to the boiler. Inch and a quarter, inch and a half, and two inch pipes are used in the Emerson system, but the inch and a quarter pipe is preferred, and supplies sufficient heating surface for ordinary emergencies, and Mr. Emerson considers 112 square feet of heating surface sufficient, which is equivalent to about 258 linear feet of inch and a quarter piping. The system is now in use on more than twenty trains daily. All of the cars piped have 55 feet sills. The trains run five, eight, seventeen, and thirty-six miles and return. The temperature may be kept at any degree of heat desired. A cold car added to a train can be made comfortable in ten minutes. Rights to use the system, at moderate rates, can now be obtained by other railroads. The method of carrying the main supply pipe is superior to anything we know of, and the system is one of the few that have graduated from the experimental stage to that of an assured success.

NOTES ON THE PANAMA CANAL.*

By R. NELSON BOYD, M. Inst. C.E.

THE following paper does not purpose to be an exhaustive description of the Panama Canal. I only submit a few notes, gathered on the spot, which therefore may have some importance at the present time, when any trustworthy information regarding the progress of the canal has especial interest.

Before entering on the description of the works, it may not be out of place to remind the meeting of the origin of this great undertaking. The Panama Canal —or, to give it the official title, "La Compagnie Universelle du Canal Interoceanique"—was constituted in March, 1881, with a capital of 1,200,000,000f., or say £48,000,000 sterling, and the works were at once commenced, and have been carried on without cessation up to the present time. The idea, however, of piercing the Isthmus of Panama is by no means a recent one. The early Spanish discoverers proposed to cut through the narrow tongue of land which separates the two oceans; and Cortez had the subject investigated, and proposed to make a canal at Tehuantepec. This was about the year 1525. Many years afterward, 1780, King Charles III. of Spain had the ground explored, with a view to making a canal. In 1804 Baron Humboldt advocated piercing the Isthmus; and in 1825 a concession was actually granted to Baron Thierry, who, however, did not bring it to any practical result. In 1830 a report on the possibility of constructing the canal was made by Messrs. Lloyd, an English engineer, and Fallmare, a Swede, and published by the Royal Society of London. This report was, however, not as detailed as it might have been; and, moreover, it was asserted that a difference of level existed between the two oceans of over nine feet, which has since been found to be fallacious. The error was no doubt caused by the difference in the rise and fall of the tides, which is a great deal more than nine feet.

Some years after this report was published—namely, in 1843-44—a French engineer, Napoleon Garella, made an exact survey of the isthmus, with the view of constructing either a railway or a canal. But his labors had no practical result. By this time the idea of cutting through the isthmus, or of constructing a railway, had been taken up by a number of people. Prince Louis Napoleon Bonaparte, then a prisoner in the fortress of Ham, beguiled his time with the study of a canal through Lake Nicaragua and the river San Juan. This project was, however, never brought to a practical issue. In fact, although the French engineers and capitalists had been turning their attention for some years to the question of constructing a canal or railway across the isthmus, their projects came to nothing; and eventually an American company got a concession and started the present Panama Railroad. The question of a canal then fell aside until the Suez Canal had been successfully opened. The United States Government were the first to take the matter up, and in 1871 sent a strong staff of engineers to Panama to survey and report. However, no serious attempt to grapple with the subject was made until the meeting of the Geographical Congress of 1871, held at Antwerp, when the possibility of constructing a canal across the isthmus was much discussed. The question was again considered at the next congress in 1875. The immediate consequence of these important discussions was the formation, in 1876, of a French committee for the study of a canal across the isthmus, with M. De Lesseps at the head of it. About this time Mr. Napoleon Wyse formed a company to defray the expenses of an explora-

* Read before the Civil and Mechanical Engineers' Society, March 30, 1887.—*The Engineer.*

tion and survey of the ground, and went out at the head of an expedition for this purpose, and ended by obtaining a concession from the Colombian Government. This concession was then submitted to the French committee, who called together a congress for the special consideration of the different projects and schemes for constructing a canal. The congress was composed of 136 members, of different nationalities, and their labors were considerable, for they had no less than fourteen different projects submitted to them for consideration. After much deliberation, this congress selected the project of Mr. Wyse for a canal, without locks, from Colon to Panama, estimated to cost 1,070,000,000f., or, allowing interest on money during construction, 1,200,000,000f.

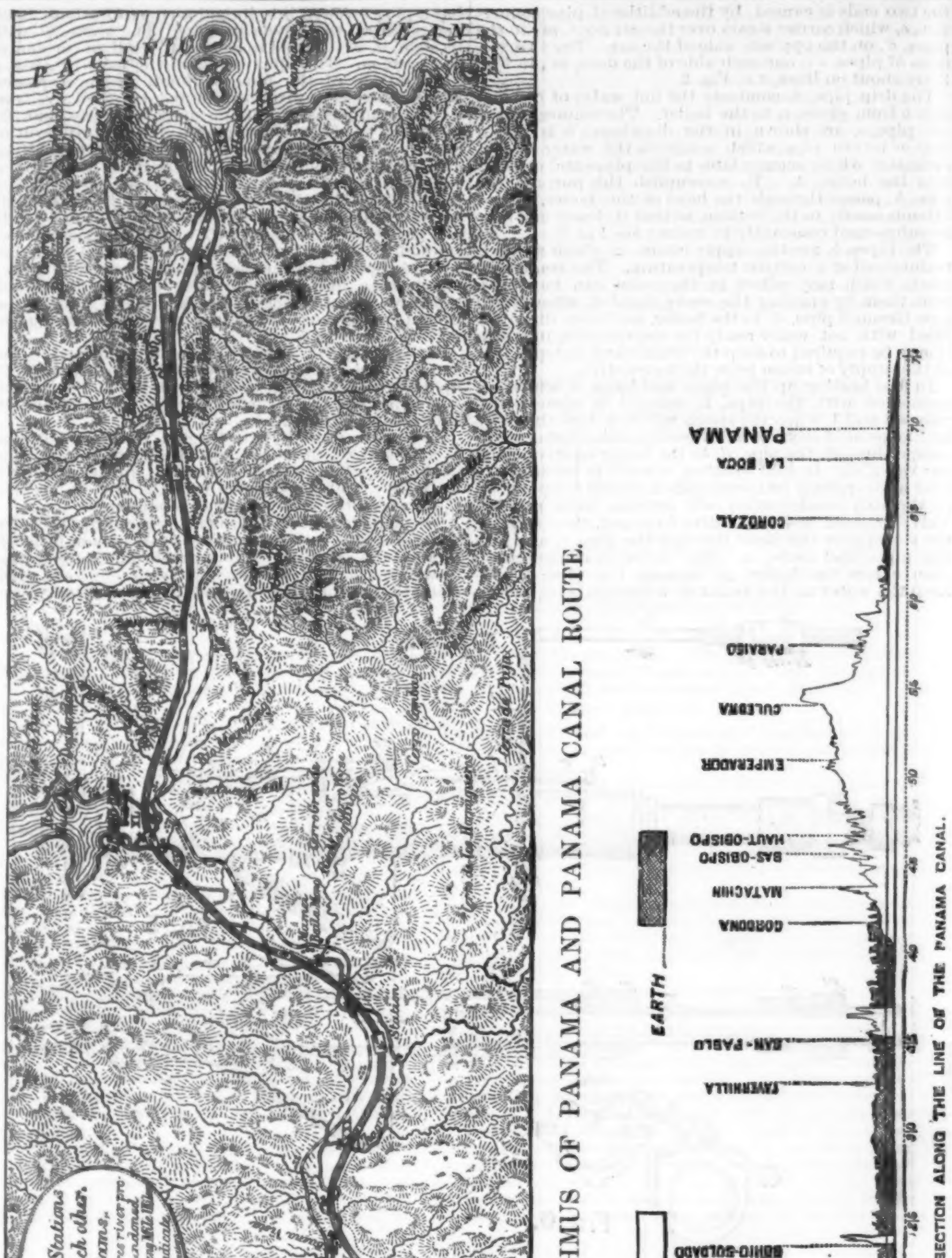
M. De Lesseps undertook to form a company, and the works were commenced in 1881. The ground was accurately surveyed, and the general plan and sections definitely fixed. The canal is to be 74 kilos. long from end to end, including 5 kilos. of dredging through the shallow estuary at the Panama end. The width of the canal at bottom is 22 meters, at top water 40 meters, and the depth of water is 9 meters. The slopes are nominally 1 to 1. From the Colon end it follows the valley of the Chagres River almost to the watershed at Culevra, a distance of over 50 kilom. But in order to do so, the river Chagres has to be deviated over a length of about 30 kilom. This is one of the great difficulties of the canal. The river Chagres drains a very large area, and during the rainy season is subject to sudden and considerable floods. This is natural with a rainfall of 3 meters per annum. It is on record that in one day of twenty-four hours, in November, the rainfall was 165 mm., or 6½ English inches. With such a rainfall over the great drainage area of the Chagres River, it is not surprising that the river at times rises 8 meters in the course of a few hours. The usual flow of the Chagres is 13 meters per second in dry weather; but during the rainy season it rises up to 184 meters, even during storms to 600 meters.

The deviation of the Chagres is a difficulty apparently not foreseen, and an expense not provided for by the early surveyors. It is in reality a necessity for the preservation of the canal, as the new bed will act like a huge ditch, and receive the surface drainage during the rains, which otherwise would rush into the canal—to say nothing of the trees, rocks, and silt brought down by these floods. The new bed of the river is to be 40 meters wide by 5 meters deep. In order to deal more effectually with these excessive floods, it had been proposed to dam up the valley at the head of the Chagres, and thus form an immense reservoir. This project is for the time abandoned. It would involve a dam about 1,445 meters long by 45 meters in height, with a cube of about 10,000,000 meters; and this would have to be constructed in the face of the floods rushing down the upper valley of the Chagres, unless the whole dam were constructed during one dry season, which is scarcely possible. At this point, known as Gamboa, the canal leaves the valley of the Chagres and crosses the watershed at Culevra. From the Culevra on to the Pacific Ocean no special difficulties have to be overcome. On this side of the watershed the river Obisbo and its confluents are regulated and deviated to form a ditch, just as the river Chagres is on the Atlantic slope. In fact, the deviations of these and other rivers and their tributaries are so arranged as to form two continuous smaller canals on each side of the main ship canal, and this may be considered as indispensable for its safety.

For some kilometers before reaching the Pacific Ocean the canal runs through swampy ground very little above sea level, and eventually joins the sea at La Boca or mouth of the river Grande. Unfortunately the water is very shallow here, and the last five kilometers have to be dredged through a bed of sand forming a wide bar at the mouth of the river Grande. Although the work has been commenced all along the line, not one length of the canal is anything like near completion. I had the opportunity of visiting most of the sections, and with the exception of the Colon end and a short length at Gorgona, where the canal follows the present bed of the river Chagres, not one of the cuttings is down even to water level, and many have merely had the surface removed. At Colon the entrance to the canal has been constructed by making an embankment which protects it from the north winds, and has reclaimed ground, formerly a swamp, on which the pleasant little settlement called "Cristophe Colomb" has been built. From the entrance the canal has been dredged to a depth of 6 meters for a length of 4½ kilom., and is open for small steamers. Three very powerful steam dredges are now at work deepening the canal down to 9 meters. After this comes a length of ground almost untouched, owing to disputes with the contractors. Then comes a length of 6 kilom. on the old bed of the Chagres, where dredges are at work deepening. These dredges have a power of 180 horse power, and raise about 3,000 cubic meters in the twenty-four hours. This seemed to me to be the best conducted work on the canal.

From this on, all the earth in the cuttings is moved by hand labor, with the narrow gauge railway known as the "Decauville," or by the steam navvy or excavator, with full sized railway wagons. The engineers advocate the latter, because they can get more work done; but some of the contractors prefer the former method. The steam navvy Osgood at work on the Tavernilla section moves 300 to 360 cubic meters in ten hours. This section is almost level. At Soldado a hill of about 65 meters in height is being removed by immense blasts of dynamite.

After Tavernilla comes San Pablo, where the canal crosses the railway, and a turning bridge will have to be constructed. A few kilometers beyond this point comes Gamboa, where the proposed reservoir was to be, and then the immense cutting of Culevra across the watershed. This is the most important work to be done on the canal. The length of the cutting is 1,800 meters, and the deepest point of the cutting 140 meters. The average for the total length is 88 meters. The height of 140 meters is not that of the center line, but the height of the summit of one of the slopes. The latter are 1 to 1, and the width at top of cutting will be from 200 to 300 meters. The quantity of earth to be moved is 20,000,000 cubic meters. At the time of my visit little work was being done, because a new firm of contractors had just taken over the cutting, and were making arrangements to suit their views. The previous contractors worked in steps, and used the small gauge



MAP OF THE ISTHMUS OF PANAMA AND PANAMA CANAL ROUTE.

SECTION ALONG THE LINE OF THE PANAMA CANAL.

Decauville railway and the steam navvy. Of the latter they had seventeen at work. Up to date about one-twentieth of the quantity has been moved, so that about 16,000,000 cubic meters remained to be excavated. This has been the work of six years. Of course much had to be done in preparatory work, such as laying roads for tipping and getting the material together. However, as it now stands, it is estimated that it will require at the very least six years to finish it. The difficulties of this immense cutting are greatly enhanced by the nature of the ground, which is in great part composed of basalt rocks—dolomite—with bands of sand intervening. Several slips have occurred and occasioned much trouble. This point is the watershed between the Atlantic and Pacific Oceans, and from this on to Panama the canal is cut through compara-

tively easy ground. The only difficulties are the deviation of the Panama Railroad and of the river Grande.

When the canal was commenced, the necessity of locks and gates was suggested, owing to the difference of tide between the two oceans. The Atlantic tide at Colon rises 2 ft., whereas the Pacific at Panama rises 20 ft., and it has been ascertained that at low water the level of the Pacific Ocean is 8·25 meters—10½ ft.—below the Atlantic. The last proposal to obviate the ebb and flow of the Pacific tide was to construct a basin near the Pacific end 4,000 meters long by 500 meters wide, lined with strong quay walls and gates on the Colon side, which would be opened at high water. The cost of this work was estimated at 50,000,000f. This, as well as all other projects of a similar kind, have been shelved for the time, and the present intention is to construct an open canal from end to end. The canal ends at or near the mouth of the river Grande, and a channel has to be dredged for a distance of 5 kilos. into deep water through a bed of sand. This is proceeding at present, and three powerful dredges are at work. These are of the Gouro model, and able to raise 150 tons per hour. I was informed that it was intended to use Gwynne's Invincible elevator on other parts of the canal, mixing two-thirds water to one-third earth, and forcing to a distance of 80 meters.

The work done on the canal is not in proportion to the time spent. Up to the end of 1886 the total cube extracted, according to the figures of the company, was under 30,000,000 cubic meters. This gives an average of 6,000,000 per year. At present the work is progressing more rapidly, and in the year 1886 the quantity moved was 11,727,000 cubic meters, or about 1,000,000 a month. During the early years of course much preliminary work had to be and was done.

Three large fitting and repairing shops have been erected, one at Colon, a second at Matachin, about the center of the canal, and a third at Boca, on the Pacific. These shops are amply fitted for repairing locomotives, dredges, engines of all kinds, and, in fact, all the machinery employed on the work. At La Boca iron barges are built as well as repaired. A good idea of the importance of these establishments may be formed from the cost, namely, over 20,000,000f., or nearly £1,000,000 sterling. These shops were intended to repair the immense quantity of machinery accumulated by the company along the railroad and the canal. In this department more waste has occurred than in any other. It is impossible to get at the value of all the machinery imported, but it has been far in excess of the requirements. Numbers of machines of all kinds are to be seen rusting along the line, and the loss is something abominable. The locomotive engines alone have been estimated at something over 57,000 horse power. I have seen a dozen locomotives, apparently in good order, shunted on a siding and left to rust away in the hot, damp climate. The rich tropical vegetation had settled on them, and green leaves were growing out of the fire doors and funnels. The waste in material is a matter of common, I may say public, comment. Thousands of barrows, wagons of all kinds and sizes, rails, and even locomotives have been tipped over the banks and buried. Lots of new and expensive machinery from Europe has been left lying along the railroad, and may still be seen gradually rusting away into valueless dross. A good deal of this material was found unsuitable when it reached the Isthmus, but it had all to be paid for.

It was soon found that in such an unhealthy climate some provision had to be made for the many cases of sickness. Accordingly two hospitals have been erected, one at Colon and the other at Panama. The former has 100 and the latter 500 beds, and this hospital consists of twenty-seven isolated wooden buildings, constructed on brick pillars rising about 10 ft. from the ground. In these hospitals the company's employes are gratuitously cared for. Those of the contractors are admitted on payment of $1 per day. In addition to these hospitals, a sanatorium has been erected on the island of Taboga, in the Bay of Panama, about ten miles from the shore.

Again, as there are no towns or villages on the Isthmus, and, in fact, no inhabitants except a few black men, who live in miserable huts, provision had to be made for housing the thousands of workmen employed. By a rough calculation made on the ground I estimate the number of houses and barracks for employes and men at over three thousand. These houses are all of wood, and were imported straight from the United States ready to put up. Lastly, the Panama Railroad had to be bought up to secure the means of transport, and nine-tenths of the shares were purchased by the company, who thus have the control of the working. The railroad remains, however, an independent American company, in order to comply with the terms of the concession. All the works are under the management of a director at Panama—invariably a French Government engineer. A large number of clerks are employed at the central office in Panama; the canal is divided into five sections under the control of two chief engineers, and each section has a resident, or *chef de section*, and the necessary complement of technical and office assistants; then come about 10,000 workmen collected from different parts of the world. I have a list of the different nationalities employed in 1885, as follows:

From Jamaica	9,006
" Carthagena	141
" Barbados	1,344
" Saint Lucia	495
" Venezuela	272
" Cuba	275
" New Orleans	542
" Martinique	800
	12,875

These proportions are fairly accurate up to the present time. It will be noticed that the great majority of the workpeople come from Jamaica and other English islands. Of course they are all black men or mulattoes. No white men can stand the climate of the isthmus and work in the cuttings of the canal. The ten or twelve thousand men employed along the forty-five miles of cuttings make a very small show, yet they are moving earth at the rate of a million cubic meters per month.

Now comes the question as to how long it will take to complete the canal at that rate. It will certainly take longer than the three years allotted. The quantities estimated and admitted as correct for the main ship canal are 120,000,000 cubic meters. To this must be added for deviating and other works at least 30,000,000 cubic meters, which gives a total of 150,000,000 cubic meters. The quantity already moved is about 30,000,000, so that 120,000,000 cubic meters remain to be excavated. Taking the present rate, namely, 12,000,000 per annum, it will take ten years to complete the work. During the first few years little excavation was done; not only had the buildings, hospitals, houses, workshops, etc., etc., to be erected, but miles of rails had to be got on the ground and laid for tipping. The latter question, though a minor one, is in many cases a serious difficulty, as the cutting is made at the bottom of a narrow valley, where the only tip room is a swamp lying above the level of the canal. All this preliminary work is now complete, or at any rate is supposed to be so, and the engineers consider that one-third of the actual work of the canal is accomplished. But if it has taken five years to do this, it will take another ten to complete the remaining two-thirds. The sanguine calculators reckon on a much larger excavation during the next few years, estimating 24,000,000 for this year and 36,000,000 for 1888, and so on. I do not think this will or can be realized. Even assuming the preparatory arrangements to be all that can be desired, an unavoidable delay will occur at the Culevra cutting. This immense and difficult work cannot be accomplished under six years, as estimated by men acquainted with the circumstances and competent to judge.

Then, again, taking the first or present rate of excavation, we are not allowing for the greater difficulties of the work as the depth increases. Up to the present time all earth moved has been close to the surface, and most of it has been moved by level roads. Later it will be necessary to raise the earth 29½ ft., and the tips will be further away, so that as time goes on we ought to reckon on a smaller and not a larger rate of excavation. It appears clearly impossible to complete the canal under six years from 1st January, 1887; and judging from all I have seen and heard, I am inclined to think that it will take nearer twelve than six years.

With regard to the cost, some figures will be interesting. First as to wages. These vary for laborers from $1.50 to $2, say 6s. to 8s., and for artisans from $3 to $4, or 12s. to 16s., so that work of any kind is most expensive. The cost of blasting and moving a cubic meter of rock may be fairly taken at 16s., and a cubic meter of earth at 8s. Now, taking the remaining 120,000,000 cubic meters to excavated at one-third rock and two-thirds earth, the total cost of moving this will come to 1,280,000,000f. To this must be added the office and general expenses of Paris and Panama, the cost of repairs, and the interest on capital during construction, and these cannot be taken at less than 1,000,000,000f. for ten years; so that the money still required, roughly calculated, will amount to about 2,200,000,000f. This estimate, founded on data independently collected, is corroborated by others, and some even put the amount above this.

The money already spent can only be surmised, but it must be very considerable. It is generally believed that more than the original capital has been already spent. Assuming that 1,000,000,000f. have been absorbed by the existing works, interest on capital, etc., the amount of capital eventually required will be over 3,000,000,000f., say £120,000,000 sterling.

Of course it is quite possible that in less time and at less cost a ditch from end to end with water flowing from the Pacific to the Atlantic may be made, but not the canal as designed, 29½ ft. deep. The impression made on the mind by a visit to the canal is a sad one. It seems as if the success of Suez was to be tarnished by the failure of Panama, and the brilliant reputation earned in the East lost in the West.

The Suez Canal has been followed too closely for a work constructed under different circumstances. The engineers at the head of Panama have been those of the Suez Canal. The section is much the same, and a great deal of the early machinery was similar to that used at Suez, though quite useless at Panama. The difficulties were underrated by the early surveyors, and the rate of wages miscalculated. Now there is uncertainty and hesitation about the plans to be adopted, and an eager but tardy straining after economy.

It is quite evident that more capital than had ever been contemplated will be required, and if this is not subscribed by the share holders, it is very possible that this great work, organized by the master mind of Suez, will be completed by other hands.

A 100 HORSE POWER SECONDARY BATTERY.

FOR a short time past, the City Hall of Paris has possessed a secondary battery that exceeds in power any that has hitherto been constructed upon the Continent. It includes 165 gigantic elements, 10 inches in diameter and 31 inches in height, each of which is capable of discharging a 240 ampere current at a tension of 1·9 volt. The power of the battery is about 80,000 watts, say a little more than that of 100 horses. Its object is to regulate the 2,200 Edison lamps that light the Hall of Fetes and the adjacent salons. Twenty thousand people had an opportunity of admiring the steadiness of these lamps at two brilliant receptions given by the municipality on the 2d and 11th of April.

The apparatus for producing the electricity of this portion alone of the illumination comprises three large Gramme dynamos and four portable steam engines, of a total power of 130 horses, located provisionally in the court of the annex, Lobau Street. The necessarily irregular operation of these temporary works well justifies the addition of a regulating battery.

This latter is placed in a neighboring cellar. Communication with the illuminated apartments is had through six subterranean cables. A switch board, devised by Mr. Chretien, chief of the electric light service, permits of rapidly effecting all the connections necessary between the lamps, dynamos, and accumulators.

The secondary battery was constructed by Mr. E. Reynier. It weighs 11 tons, and contains 975 gallons of liquid. The elements of which it is composed are of the Plante spiral type; but the details of construction had to be subordinated to the dimensions and destination of the apparatus.

The two electrodes of each element are strengthened with orlets. One of them is fluted, in order to give stiffness to the whole and assure of the disengagement of the gas. The connecting pieces are greatly strengthened, and are protected against electro-chemical and mechanical causes of destruction. An efficient and durable insulation of the plates is secured through a continuous and permeable triple partition, made of cotton, hemp, and wool superposed.

100 HORSE POWER BATTERY AT THE CITY HALL, PARIS.

The glass vessel is protected against internal and external shock by fenders formed of felt, and is surmounted by a cover that shuts in the whole and moderates the evaporation of the liquid. Strong bolts of an alloy of lead and antimony assemble the elements in three equal and distinct series.

The power of regulation of a secondary element depends upon its internal resistance, which should be as slight as possible. Mr. Reynier therefore gave the electrodes a wide surface—one of 76 square inches. As for the "formation," that was prepared by the Plante chemical treatment. So these vessels will, a little later on, merit the name of accumulators; provisionally, they are called voltameters. Their electro-chemical capacity might reach a million coulombs. The contract calls for but 300,000 coulombs, which are sufficient to keep up the light for from 20 to 30 minutes in case of an accidental stoppage of the machines. A certain number of voltameters, mounted in supercharge, would then be interposed in the lighting circuits in order to compensate for the diminution in electromotive force suddenly produced by the failure of the works.

On account of the dampness of the cellar in which they are placed, certain precautions have been taken for the insulation of the elements. Dangers of explosion, too, had to be looked out for. The battery operating under supercharge disengages from 210 to 280 cubic feet of explosive gas per hour, and this is carried off by an air exhauster actuated by a small Gramme machine supplied by a derivation from the main circuit.

This exhauster sucks in the gases at the upper part of the cellar and forces them into the court. It discharges 4,200 cubic feet per hour, with an expenditure of power equal to 21¾ foot pounds.

The introduction of this battery into the illuminating plant of the City Hall is due to the late Mr. Bartet, assistant director of the public works of Paris, whose recent death has caused unanimous regret. The first project of this distinguished engineer included a battery of accumulators capable of keeping up, of themselves, a brilliant illumination of the Hall of Fetes for an entire night. The charging would have been effected, in advance and at leisure, by the ordinary electric plant of the premises, and there would thus have been obtained a perfectly steady light and absolute security.

This project having been abandoned for financial

reasons, Mr. Reynier submitted a mixed solution of the question to Mr. Bartet—the addition of a relatively cheap zinc-lead regulating battery. But certain objections made by the municipal committee caused the zinc-lead voltameters to be replaced by the ones just described, and which are, in Mr. Reynier's opinion, less efficient as regulators than the zinc elements. On the contrary, Plante elements are more apt to be "formed" as true accumulators. If it be decided, as we hope it will, to give them a sufficient formation, there will be no longer anything to be regretted, since the battery will become capable of rendering important services in every day lighting, independently of its role in exceptional circumstances.

However this may be, the City Hall battery may be considered as a remarkable example of the use of accumulators in lighting.

In the near future, one hundred horse secondary piles will become quite common; but at present, we know of no other than the one under consideration, either in France or elsewhere.

The municipal battery might, moreover, prove of service to physics by rendering experiments possible that are performed with difficulty by other means.

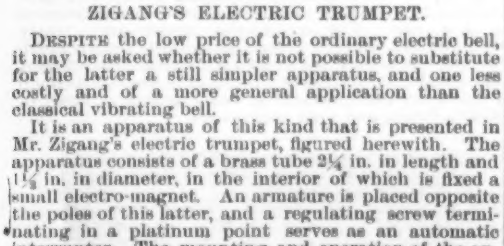
Through different couplings, the 100 electric horse power might be used in a large number of forms, from the maximum potential of 330 volts, with an intensity of 240 amperes, to the minimum potential of 1·9 volt, with a discharge of 40,000 amperes.

The directorship of the public works of Paris, which is endowed with a liberal spirit, would doubtless put the battery at the disposal of physicists who are desirous of making it contribute to some fine experiment on a large scale.—*La Nature.*

ZIGANG'S ELECTRIC TRUMPET.

DESPITE the low price of the ordinary electric bell, it may be asked whether it is not possible to substitute for the latter a still simpler apparatus, and one less costly and of a more general application than the classical vibrating bell.

It is an apparatus of this kind that is presented in Mr. Zigang's electric trumpet, figured herewith. The apparatus consists of a brass tube 2¼ in. in length and 1½ in. in diameter, in the interior of which is fixed a small electro-magnet. An armature is placed opposite the poles of this latter, and a regulating screw terminating in a platinum point serves as an automatic interrupter. The mounting and operation of the apparatus may be understood from a simple inspection of the figure. It takes but two Leclanche elements of the usual electric bell variety to cause it to produce an agreeable musical sound, of which the pitch and intensity may be varied by regulating the screw or tightening up the vibrating plate in its setting.



ZIGANG'S ELECTRIC TRUMPET.

This characteristic musical sound permits of the apparatus being used for domestic and telegraphic purposes, where there is need of distinguishing different calls without having recourse to indicators. It might also render service upon railways, tramways, boats, etc., in all those cases where there is need of a signal insensible to the more or less abrupt motions of the object under way. Finally, the possibility of transmitting the Morse alphabet and certain conventional signals by sound permits of the electric trumpet being applied for the transmission of signals to an engine room, in cases where noise prevents the use of a telephone.—*L'Electricien.*

[NATURE.]

AN EQUATORIAL ZONE OF ALMOST PERPETUAL ELECTRICAL DISCHARGE.

THE recent reference in your columns to Edlung's theory of the aurora borealis recalls a very curious observation that I have made in my travels of a zone of almost perpetual electrical discharge in the belt of the "doldrums" all round the world.

Anywhere in that belt, a more or less intermittent display of sheet lightning commences the moment the twilight of sunset has sufficiently faded away, and continues with varying intensity till the light of morning prevents further observation.

The localization of this belt of lightning is very obvious as we run a section across the equator on board ship. There is very little electrical discharge in the high pressure belt of anticyclones which encircle the earth approximately under the lines of the tropics. But as we approach the low pressure band of the "doldrums," where the two trade winds, or the two monsoons, meet, then the display of lightning is of nightly occurrence, even if there are no actual thunderstorms.

This electric discharge has a diurnal period like every other meteorological element. For night after night, as I have slept on deck in Malaysia during the change of the monsoons, I have noticed a very marked diminution of the lightning after 1 or 2 A. M. If a total eclipse of the sun could last for twelve hours, I have no doubt that we should see more or less lightning all the time, with a regular set of diurnal variations.

Edlung and others have noticed the gradual decrease in the frequency of thunderstorms as we recede from the equator. But I wish to show now, not only that the discharge is of nightly occurrence, but that the locality of maximum effect is not so much on the equator as in the "doldrums." The sheet lightning may be the reflection of distant thunderstorms, or it may be the silent discharge of electricity. Meteorologists are much divided as to the possibility of the latter. But it is certain that the amount of sheet lightning is out of all proportion to the frequency of actual thunderstorms.

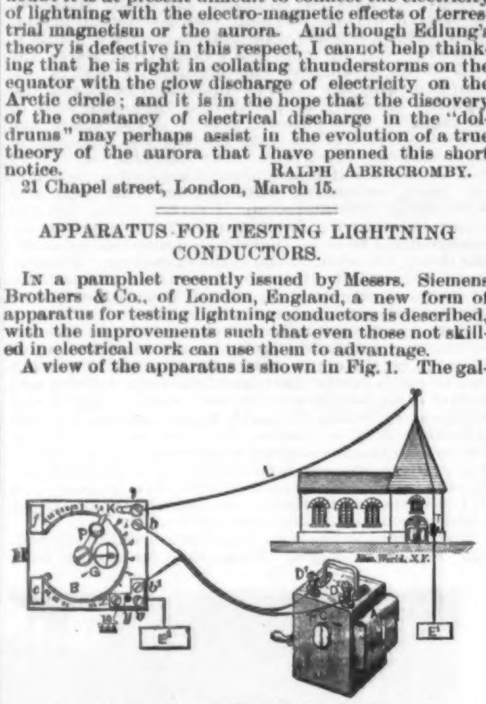
Is it possible that we may find in this perpetual lightning some clew to the origin of earth currents everywhere? and in the diurnal variation in the discharge, some probable reason for the hourly variation of the aurora and of some magnetic elements? No doubt it is at present difficult to connect the electricity of lightning with the electro-magnetic effects of terrestrial magnetism or the aurora. And though Edlung's theory is defective in this respect, I cannot help thinking that he is right in collating thunderstorms on the equator with the glow discharge of electricity on the Arctic circle; and it is in the hope that the discovery of the constancy of electrical discharge in the "doldrums" may perhaps assist in the evolution of a true theory of the aurora that I have penned this short notice. RALPH ABERCROMBY.

21 Chapel street, London, March 15.

APPARATUS FOR TESTING LIGHTNING CONDUCTORS.

IN a pamphlet recently issued by Messrs. Siemens Brothers & Co., of London, England, a new form of apparatus for testing lightning conductors is described, with the improvements such that even those not skilled in electrical work can use them to advantage.

A view of the apparatus is shown in Fig. 1. The gal-



FIGS. 1 AND 3.—TESTING LIGHTNING CONDUCTORS.

vanometer is represented as removed from the compartment provided for it in the bottom of the case containing the magneto-generator, and is in connection with the terminals of the latter. Fig. 2 is a general plan, and Fig. 3 a diagram of the connections between the magneto bridge-board, two earth connections, and the lightning rod. The apparatus consists of a magneto, M, inclosed in a wooden case, and bridge-board, B. On the latter are fixed a ring of German silver wire (forming the A and B branches of a resistance bridge); a contact lever, P, which can be moved over the ring and used as a battery key; a small horizontal galvanometer, G; a brass sliding piece, *s*, for putting the galvanometer needle in and out of action; four terminals, *b*, *b*¹, *e*, *l*; and R (see Fig. 2), the comparison resist-

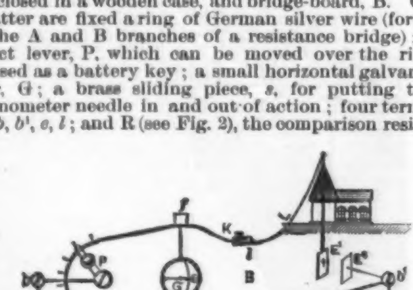


FIG. 2.

ance of the bridge. A small key, K, is fixed to terminal, *l*, and the resistance, R, is underneath the bridge-board. A leather bag, A, at the side of the wooden case, Fig. 3, serves to hold the double conductor leading wire, which is used for connecting the magneto terminals with the bridge-board. The weight of the complete apparatus is 9 lb., and the dimensions are about 6″ × 6″ × 9″. By means of this testing instrument the low electrical resistance of lightning conductors, earth connections, and leading wires of electric light installations, as well as the higher resistances of line wires for telegraphic and telephonic circuits, connection wires in telegraph stations, etc., can be measured, the range of the instrument being from 0·1 ohm to 500 ohms. The measurement of a resistance is read off direct without the trouble of making any calculation.

The connections for testing are made as follows: Terminal, *l*, Fig. 3, is joined to the apex of the lightning conductor by means of a length of leading wire, which may be either bare or insulated. If bare wire be used, precautions must be taken that no part of it, throughout its entire length, makes contact with any object, so as to short circuit the current. Terminal, *e*, is put to earth, that is, a connection is made by means of a stout piece of copper wire between this terminal and a gas and water pipe, and, should not these be at hand, any metallic body in intimate contact with wet earth may be used in place of the pipes. When no such earth connection is available, a special copper plate (E^2) must be employed, and put underground at such a depth as will insure all parts of the plate being in good contact with moist earth.

Terminals, *b b*¹, are joined to D^1 D^2 of the magneto, Fig. 3, by means of the double conductor leading wire, in the bag, A. The bridge board, B, must stand as far away from the magneto, M, as the leading wire will permit, so that the galvanometer, G, may remain as much as possible out of range of the magnetic and inductive influence of the permanent magnets and revolving armature of the magneto.

After the slide, *s*, has been withdrawn and the galvanometer needle set free, the bridge board must be so placed that the needle plays freely over the scale, and finally points to zero when at rest. The bridge board is then fixed by means of brass weights or clamps in the position thus found, but no iron must be used for this purpose. All connections must be firmly made, and the attachments of the earth wire to a water pipe, gas pipe, etc., should be well soldered.

The tests are taken by two persons, one at the magneto and the other at the bridge board. The magneto switch, C, is moved so that the arrow points to the positive sign, +; the handle of the magneto is then turned so as to keep the speed at a uniform rate. While the latter is being turned, the key, K, of bridge board is depressed with one hand and the pointer, P, with the other. The current from the magneto then traverses the bridge, and a deflection of the galvanometer needle is produced; the key, K, is still held down and the pointer, P, kept depressed and moved a little to the right and left, observing at the same time which of these movements causes a decrease of the deflection. As soon as this is ascertained, the pointer is kept moving slowly around the German silver ring until a point is found which brings the galvanometer needle back to zero. The figure over which the pointer, P, now rests is recorded on a piece of paper. It gives in ohms the total electrical resistance of the lightning conductor and its earth connection, leading wire between the apex of conductor, and terminal, *l*, and earth plate, E^2.

The switch, C, is now moved so that the arrow points

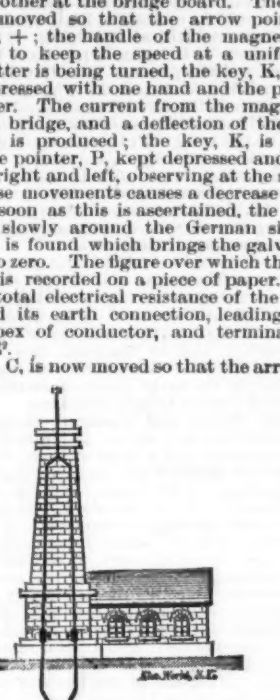


FIG. 4.

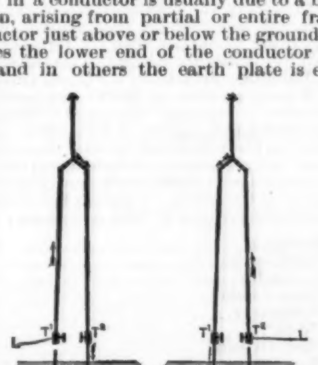
to the negative sign, —, and the handle of the machine turned as before. A slight deflection on the galvanometer will be observed, and the pointer, P, must be moved to one side or the other of its first position until the needle again points to zero. The figure now under the pointer must be read off and also noted down. It gives the total resistance in ohms, when the test is taken with a negative current, the previous one having been made with a positive current.

A number of these reversal tests may be taken, and the mean of all tests will give the correct resistance of the conductor, leading wire and two earth connections. The resistance of the leading wire, L, and the earth plate, E^2, is so low that it may be neglected; the mean of the tests, therefore, can, in practice, be taken as the actual resistance of the lightning conductor and its earth connections, E^1. A resistance of more than 20 ohms shows the conductor to be in such a state as to have become a positive danger to the building to which it is fixed.

While the tests are being taken, the bridge board, B, must be kept in its normal position, that is, with the galvanometer needle pointing to zero, so long as the key, K, and pointer, P, are not depressed, and the screw marked $\frac{10}{500}$, Fig. 3, must be well secured between the terminals, *e* and *z*.

At the time a lightning conductor is erected, one end of a length of copper wire should be firmly soldered to the apex of the conductor. This wire is carried down loosely by the side of the conductor and remains permanently in position, so as to be available for connection with the testing instrument whenever the entire length of the conductor has to be tested. By this means the trouble and expense of attaching a fresh leading wire for every test are avoided.

A fault in a conductor is usually due to a bad earth connection, arising from partial or entire fracture of the conductor just above or below the ground line. In some cases the lower end of the conductor is in dry ground, and in others the earth plate is either too



FIGS. 5 AND 6.

small or is oxidized and broken. The earth connection should, therefore, be tested first of all, and for this purpose a strong brass clamp with terminal screw, T, Fig. 3, should be secured to the conductor just above the ground line and well soldered. A separate short length of leading wire is then used for connecting terminal, *l*, of the bridge board with terminal screw, T, on the lightning conductor.

Double rod conductors of the same sectional area as a single one can be erected. The testing of conductors of this kind is very readily carried out. The upper

end of each rod, Fig. 4, is well soldered to a point common to both rods, and at the base the two ends terminate just above the ground line. To the earth plate, E', are soldered two rods which terminate close to the upper ones and are joined thereto by means of connection screws, T^1 T^2. Either of these screws can be connected to the testing instrument by a leading wire.

To test such a twin conductor, first one rod at T^1 is disconnected, Fig. 5, and one end of the leading wire joined thereto, the other end being connected to terminal, *l*, of bridge board, as in Fig. 3. The test is then made as described in the case of single conductors and the continuity of the right hand rod tried. The left hand rod is tested in the same way, after the connections have been made, as shown in Fig 6 In erecting a double conductor, the two rods must be kept some distance apart throughout their entire length, and not touch any piece of metal forming part of the building, so as to obviate all risk of the two rods being short circuited. After the tests have been taken, the connections must of course be remade, as in Fig. 4.

The testing of lightning conductors should be carried out in dry weather, as better and more concordant results are obtained than in a damp state of the atmosphere, when buildings are covered with moisture.

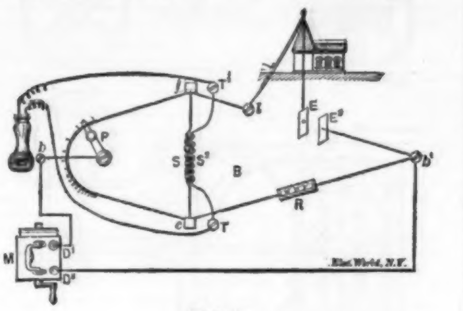


FIG. 7.

When the earth connection, E^1, is connected to terminal, *l*, and earth plate, E^2, to terminal, *e*, Fig. 3, a weak current, due to the difference of potential of the two earth plates, passes through the galvanometer and deflects the needle, which, under these conditions, cannot be maintained in its normal position at zero. This difficulty is, however, overcome by the introduction of the key, K, which prevents any current from traversing the galvanometer until the key be pressed down. When adjusting the bridge board, the key, K, is open and the needle can readily be brought to zero, as it remains free from the disturbing influence of the current set up between the two earth plates. As soon as the key, K, is depressed, the circuit formed by the two earth plates, E^1 E^2, lightning conductor, leading wire, L, key, K, *f*, galvanometer, G, *c*, R, and b^1, Fig. 2, is completed and the needle deflected. When accurate tests are required, this deflection, which is clearly due to a current between the earth plates, must be eliminated by taking a few tests alternately with positive (+) and negative (−) currents. The figures obtained in the one case will be too high and in the other too low, but by taking the mean of the results, the resistance of the lightning conductor is obtained with sufficient accuracy for all practical purposes.

The continuous current from the magneto has an electromotive force of about 5 volts, which is sufficient to polarize the two earth plates, E^1 E^2, and thereby increase the resistance to be measured. This effect impairs the correctness of the tests in direct proportion to the time occupied in taking each test. The necessary measurements should therefore be made with as great rapidity as possible. By means of the switch, C, Fig. 3, the tests are taken with reversed currents, in order to neutralize the polarization of the earth plates.

For testing telegraph and telephone lines, as well as other resistances higher than those of lightning conductors, the brass screw marked $\frac{10}{\text{fold}}$, Fig. 3, which connects *e* and *x*, must be removed. The readings now obtained

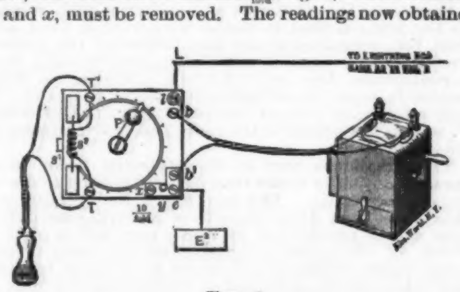


FIG. 8.

by means of the pointer, P, must be multiplied by 10 in order to give the true resistance of any line, etc., under measurement. The range of the instrument when the $\frac{10}{\text{fold}}$ screw is in its place is 0·1 to 50 ohms, and without this screw, 1 to 500 ohms, thus enabling the operator to measure small resistances as well as comparatively high ones without making any alteration in the connections. The tenfold screw when removed from its usual place is put into the hole, *y*, provided for it.

In order that resistance tests may be taken by means of the telephone in conjunction with the magneto and bridge board, as proposed by Captain Addison, R.E., secretary of the Royal Engineer Committee, Messrs. Siemens Brothers & Co. have introduced another form of the apparatus, shown in Figs. 7 and 8.

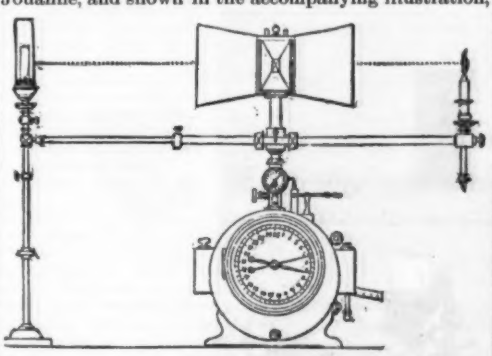
In this arrangement a telephone is connected to the terminals, T T^1, the center of the bridge being occupied by an induction bobbin, the primary coil, S^1, of which is attached to terminals, *f c*, Fig. 7, and the secondary coil, S^2, to the terminals, T T^1. The magneto is arranged to give alternate currents, which produce a continuous sound in the telephone. The magneto switch used in the other testing apparatus for reversing the continuous current is not required in this instrument, and, as there is no galvanometer needle, the key, K, is dispensed with. In other respects, the testing bridge is similar to that first described.

When a test is being taken, the handle of the magneto generator is turned by one operator, while the other holds the telephone to his ear, depresses pointer, P, and moves it over the branch resistance ring, until a point is found at which the sound is either reduced to a minimum or is altogether absent. The figure marked by the pointer then gives the actual resistance of the lightning conductor or line under measurement, without the necessity of taking the mean of several tests, as is the case when the tests are taken with continuous positive and negative currents. The polarization of the earth plates is also neutralized by employing alternate currents. As the noise caused by the revolving armature of the magneto might interfere with the test, it is advisable to use longer leading wires than those required with the other apparatus, in order to keep the telephone as far away from the magneto as possible.

M. JOUANNE'S DOUBLE PROJECTION PHOTOMETER.

AMONG the numerous difficulties and causes of error which photometrical observations generally present to those who are not in the habit of conducting them, perhaps the principal one is the different appreciation which operators have of the identity of illumination when the two sides of the screen receive rays of different shades. The gas flame produces a coloration quite unlike that given by the flame of a candle or of a Carcel lamp; and this variation often gives rise to discrepancies and inaccuracies when it is necessary to estimate exactly the intensity of two differently colored lights.

The new arrangement of photometer devised by M. Jouanne, and shown in the accompanying illustration,



is intended to give a greater precision to photometrical observations, by rendering them independent of the influence which the difference in the color of the two luminous sources exercises upon the eyes of the observers. The essential principle of the arrangement consists in the combination of the two methods of observation employed up to the present time, viz., that of the equality of luminous tints (the principle of the Foucault photometer) and that of the equality of shadows (the principle of the Rumford photometer). In this apparatus the two projections of the lights and shadows are produced simultaneously on the same screen, and consequently furnish a double element of appreciation, which renders photometric operations easier and more certain, even for those who are the least experienced in conducting these observations.

In the general form of the apparatus, represented in the illustration (which, with the following description, is taken from a recent number of *Le Gaz*, of which M. Jouanne is the technical editor), the candle is adopted as the standard of light and is placed at a variable distance from the screen; but the apparatus may also be arranged with a Carcel lamp, which would be located at a definite distance, while the position of the candle would be variable. In order to render the appliance in its entirety as simple as possible, the box of the photometer is mounted directly upon the experimental meter. Consequently, the operator has before him, visible at a glance, the dial of the meter, the minute clock, and the sight hole through which he observes the appearance of the screen. The gas on leaving the meter passes into the vertical pillar supporting the photometer; the current of gas being regulated by a graduated screw tap.

From the vertical pillar branches the horizontal bar whereby the gas is conducted to the burner, which is placed at a fixed distance from the screen, and supported upon a sliding rod, which allows the position of the flame to be so regulated as to keep the two lights always on the same horizontal line passing through the axis of the instrument. The candle is placed at the extremity of a two branched slide, by means of which the candle may be brought to any required distance to obtain the desired equality of shadows and luminous tints projected upon the screen. A series of graduations marked upon the front bar of the slide will show at a glance the proportionate value in candles of the two lights when the equality of lighting of the screen has been ascertained.

The photometer box, of quadrangular form, presents to the two lights (placed right and left) its two lateral openings, by which the luminous rays are enabled to fall upon two mirrors crossing each other at an angle of 45°, and each occupying half the height of the central portion of the box. One of the mirrors (the lower one, for example) receives the light of the candle; the other placed above it, that of the gas jet—each reflecting the luminous rays upon the corresponding halves of the screen, which is fixed in the box on a vertical plane parallel with the axial line of the lights. At the same time two small vertical rods, interposed between the mirrors and the screen, project their shadows upon the latter in such a way that the shadows are divided into two vertical zones, each of which corresponds to one of the mirrors and to one of the halves of the height of the screen. When it is desired to employ as a standard of light the Carcel lamp instead of the candle, the lamp is placed at a fixed distance from the screen, and the gas jet is mounted at the extremity of the movable branch. In this case it is supplied with gas through an India rubber pipe, which, of course, can be shortened or lengthened as required.

This photometer is constructed in various forms, to suit all requirements; but the fundamental idea in them all is the simultaneous projection of luminous tints and shadows upon the same screen, thereby affording two means—the one a check on the other—of estimating the value of the light. This is the characteristic feature of M. Jouanne's photometer, which is claimed to be a more simple and economical instrument than that of Dumas and Regnault, while the results obtained with it are equally reliable.—*Journal of Gas Lighting.*

PERRON'S PHOTOGRAPHIC APPARATUS.

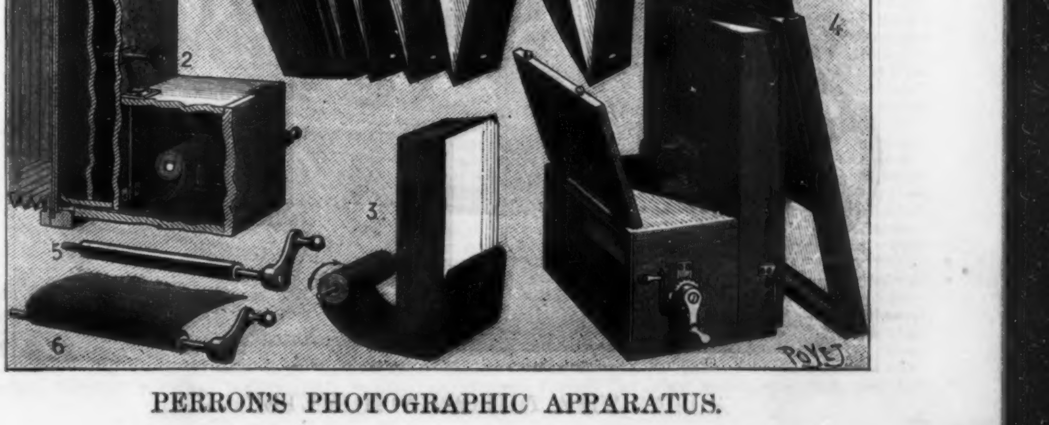
THE Perron photographic apparatus and process, which we are about to describe, are entirely new. The process consists in the use of sheets of gelatino-bromide of silver emulsion, with a view of obtaining ordinary negatives without the intervention of glass, which is always heavy, fragile, and cumbersome. The process is completed by a special frame, which permits of using these emulsions for a large number of exposures, without recourse to the special light of a laboratory to effect the substitution of them.

The emulsions are composed solely of the usual substance spread upon those gelatino-bromide plates which are so universally employed, thus permitting of the use of every known kind of development without any change in formulas, and securing an absolute transparency in the negatives. Glass or supports of varying transparency are entirely suppressed, and one has no longer to bother with those special baths that are used to give certain of these supports the necessary transparency. Finally, the apparatus that permits of the use of these plates in the open air for the various exposures has been so studied as to make it adaptable to all existing cameras without exception, thus causing merely an expense for a slight change, and allowing every one to use all his own *materiel*.

The emulsions come packed in cardboard boxes that contain a package of black paper in folds. (Fig. 1.) Between the folds of this paper are inclosed the sheets of emulsion, which are glued to it by their lower edge, and are thus protected on both faces. The frame consists of a sort of box sufficiently deep to hold one package of emulsions, which a movable board with a regulating screw, permits of holding against a very clear piece of glass set into the back of the flap door of the apparatus, and corresponding exactly to the plane of the focus (Fig. 2).

After the package of emulsions has been put into the box, the first sheet of black paper is passed through a slit and made to engage with a groove in the axis of a winch, that permits of unwinding it from the exterior (Figs. 2, 3, and 6). Each sheet of black paper is provided with a hole, through which runs a vertical rod (indicator), whose head is visible on the outside. When the paper is rolled up, so that a sheet of emulsion is in place, and ready for exposure, the rod falls into the hole and shows that the winch has been turned sufficiently.

When, after an exposure, it is a question of removing the plate that has been exposed and of substituting another for it, it is only necessary to raise the indicator



PERRON'S PHOTOGRAPHIC APPARATUS.

so as to free it from the nole, and then to turn the winch until the indicator falls into the succeeding aperture. This brings the next plate into position. This process goes on until the exhaustion of the package, which contains 12, 24, or 36 plates, that permit of taking on the same excursion just as many negatives, with one frame and without having recourse to a laboratory.

Upon returning home, the emulsions that have been exposed are taken out through the back of the frame by unrolling them; and it is possible either to continue with those that remain, if the package has not been exhausted, or to put in another package if the first has been all used up.

After all the usual operations of developing and fixing, the negatives are immersed in a peculiar solution of gelatine, which, after they are dry, gives them strength and extreme flexibility. They are then spread out upon very clean glass to dry. The plates after this have the appearance of absolutely transparent paper, and possess the flexibility and strength of taffeta, and can be sorted out without any danger of their being torn. The negatives can thus be placed between the pages of an indexed register, and be stored with numerous works within an extremely limited space.—*La Nature.*

THE AUTOGRAPHOMETER.

How long, laborious, difficult, and delicate the operations generally are that are necessitated by the topographical survey and leveling of a place is well known to every one. Not to speak of the office work, which is by no means the least arduous part, the field operations are often apt to be interrupted by fog, rain, wind, or simply by nightfall.

The apparatus which we are about to describe, and which was invented by Messrs. Panon & Floran de Villepigue, engineers, is designed for very quickly obtaining the topography and level of any place whatever, and for simultaneously drawing it to a known scale. It is called the autographometer, from αὐτός, "one's self," γραφειν, "to write," and μετρον, "measure." As shown in Fig. 1, it consists of a small carriage mounted upon three wheels. It suffices to draw this vehicle (which is about 2½ feet long by 2⅓ wide) in any given direction, in order to obtain the topography and level automatically.

FIG. 1.—THE AUTOGRAPHOMETER.

The apparatus operates as follows: The wheels serve as a motor to an arrangement which is inclosed and hidden, and which draws two diagrams to a given scale—one of which gives the bearings and elements of the road, and the other the elevations of the land. Here and there, at every half mile, for example, an electric bell or other signal notifies the person who is drawing the vehicle that the paper is full and that it is necessary to put in other sheets.

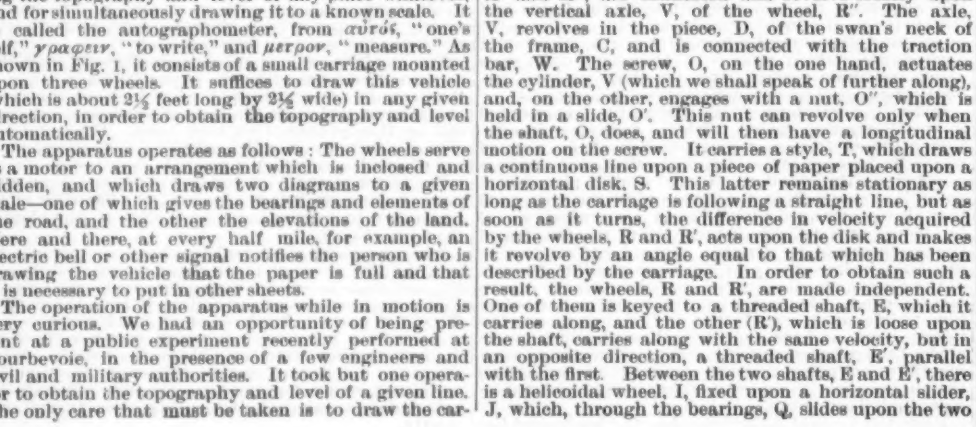
The operation of the apparatus while in motion is very curious. We had an opportunity of being present at a public experiment recently performed at Courbevoie, in the presence of a few engineers and civil and military authorities. It took but one operator to obtain the topography and level of a given line. The only care that must be taken is to draw the carriage along with regularity and without jerks. The sole fatigue is that which results from the traction of the vehicle, which weighs less than 200 pounds—a weight that might be much diminished. The paper used for obtaining the diagrams is covered with zinc white. The styles are simple copper wires with a blunt point. These styles do not, like lead pencils, have to be sharpened, but always give a fine and uniform black line.

If celluloid in thin sheets be substituted for paper, the apparatus can be operated under water. This is a feature of which some application may be made. It is well to remark that it is possible to work at night also, provided the operator can see well enough to follow the route that it is desired to survey. As the apparatus is entirely inclosed, an accidental rain cannot interfere with operations, and the drawings and mechanism are in all cases protected against accidental shocks and the observation of the curious.

We shall raise the cover of the box, in order to allow our readers to examine at leisure the operation of the different pieces of mechanism.

The elevation (No. 1, Fig. 2) and plan (No. 2) sufficiently show the relative position of the different pieces. The explanation that we shall give may be very easily followed with the aid of the figures. One portion of the apparatus is designed to register the plan of the route, that is to say, the elements of the route and the angles they make with each other; the other portion registers the profile lengthways, that is to say, the length and level of the route.

The plan is registered as follows: When the carriage is drawn along in a straight line upon the earth, the three wheels, R, R', R'', placed at the apices of an isosceles triangle, move in parallel planes and describe equal lines. The wheels, R'', through gear wheels, H and H', connected by the pitch chain, *g*, revolve the screw, *o*, through the intermedium of the helicoidal wheels, Y H'', and the bevel wheels, X X'. The wheels, X' and H'', are connected and revolve loosely upon the vertical axle, V, of the wheel, R''. The axle, V, revolves in the piece, D, of the swan's neck of the frame, C, and is connected with the traction bar, W. The screw, O, on the one hand, actuates the cylinder, V (which we shall speak of further along), and, on the other, engages with a nut, O'', which is held in a slide, O'. This nut can revolve only when the shaft, O, does, and will then have a longitudinal motion on the screw. It carries a style, T, which draws a continuous line upon a piece of paper placed upon a horizontal disk, S. This latter remains stationary as long as the carriage is following a straight line, but as soon as it turns, the difference in velocity acquired by the wheels, R and R', acts upon the disk and makes it revolve by an angle equal to that which has been described by the carriage. In order to obtain such a result, the wheels, R and R', are made independent. One of them is keyed to a threaded shaft, E, which it carries along, and the other (R'), which is loose upon the shaft, carries along with the same velocity, but in an opposite direction, a threaded shaft, E', parallel with the first. Between the two shafts, E and E', there is a helicoidal wheel, I, fixed upon a horizontal slider, J, which, through the bearings, Q, slides upon the two shafts, E and E'. This wheel forms a nut which is movable with respect to the shafts, E and E'. These latter have the same velocity as the wheels, R and R'. If one of these wheels revolves faster than the other, the corresponding shaft, turning faster likewise, will carry the nut wheel, I, along with it. This side motion is converted in the rotating disk, S, into a rotary one through the intermedium of the double sector, K, and directing cycloid, U. This sector is movable around the same vertical axis as the wheel, I, and gears with a pinion, P, keyed to the center of the disk, S, which, therefore, revolves by a certain angle as soon as the wheels, R and R', acquire different velocities, that is to say, as soon as the vehicle is turned.



THE AUTOGRAPHOMETER.

The style, T, which traces a radius, *o a*, upon the disk, S, will trace an arc of a circle, *a b*, every time the

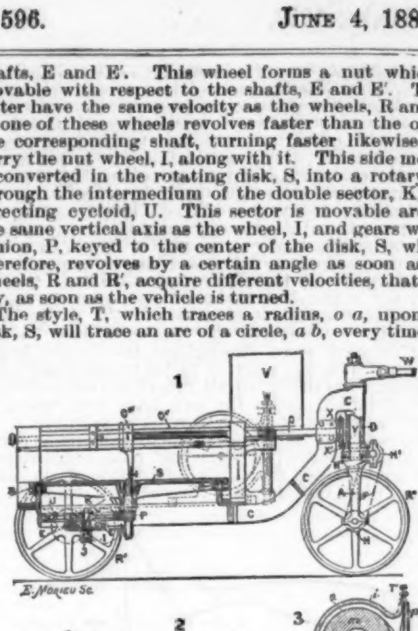


FIG. 2.—DETAILS OF THE MECHANISM.

disk revolves, and the angle of this arc at the center measures the angle of rotation of the disk, and, consequently, that of the carriage. If, afterward, the carriage be drawn along in a straight line, the style will trace another radius, such as *b c*, and so on, giving a series of straight lines and arcs, or the resultant of the two motions (*e f*), of which the entirety, *o a b c d i f g h i j k* (Fig. 3), will be a diagram from whence we shall be able, quickly and accurately, to draw all the elements of the plan of the route that has been passed over. Let us now see how the profile lengthways is registered.

We have seen that the wheel, R'', causes the cylinder, V, to revolve through a thread of the screw of the shaft, O, and a helicoidal wheel carried by the cylinder itself. If we suppose that the style, T', is bearing against this cylinder, it will trace a continuous, horizontal straight line, whose length will be in a determinate ratio to the line passed over.

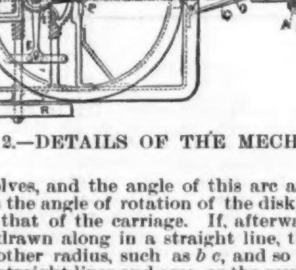


FIG. 3.—DIAGRAM OF A PLAN.

Supposing the style rises and descends with respect to the horizon that it would trace were it fixed, and that, too, according to the inequalities of the ground over which the apparatus is drawn, and we shall have a continuous line, *a b c d e f g h i j k* (Fig. 4), with gradients equal in ordinates to those of the land. It only remains to unwind the paper from the cylinder, V, to find the profile of the route passed over drawn to a definite scale.

The intelligent part of the style—its brain, so to speak—consists of a cast iron box, *i*, fixed to the side of the carriage frame. This box (Fig. 2, No. 3) contains a thin sheet iron drum capable of revolving around an axle, ω, and provided at its upper part with a piece of wood, *m*. In a lateral groove, and between several small rollers which are designed to diminish friction, and which are so arranged as to diminish the play in every direction, slides a rod, *r*, which carries the style, T', of the cylinder, V. This rod is connected with the drum by two thin pieces of steel, which cross each other and are attached at *o* and *n'* and *p* and *n* to the drum and rod. These pieces are submitted to a tension, and there is thus obtained an elastic connection, without play, between the drum and style. The interior is then filled with mercury. The drum, *t*, and the wooden piece, *m*, form as a whole a body floating on a liquid, and capable of revolving around an axis, which is the center of thrust. The result is that the center of gravity of the whole must always be on the vertical that passes through the axis, ω. If, then, the carriage inclines in one direction or the other, the internal drum will at the same time revolve by the same angle, and in an opposite direction, in order that its center of gravity shall always be upon the vertical passing through the axis, ω. This circular motion of the drum is transmitted integrally, in becoming a rectilinear vertical one, to the drum, T', which lowers when the vehicle is

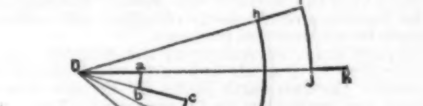


FIG. 4.—DIAGRAM OF A PROFILE.

ascending an elevation, and rises when it is descending a slope.

Upon bringing together the two diagrams furnished by the apparatus, we can very quickly obtain the plan and profile of the ground passed over on any scale whatever. It would be only necessary, moreover, to vary the ratios of the gearings, X and X', in order to obtain the profile directly on a scale fixed in advance. In this case, we have nothing to do but translate the diagram representing the plan.

This apparatus requires to be constructed with great care; but, seeing the progress that has been made in the minor branches of mechanics, there is no difficulty about this.

Although the public experiments at Courbevoie showed a few slight imperfections in the construction and operation of the disk, S, we think that an apparatus of the nature of the autographometer will be called upon to render genuine services in special cases.—*La Nature.*

A GRIST MILL OF 1819.

THE old "bragh," as it was called, now adorns the museum of the Canadian Institute in this city, having been recently presented to that institution by its former owner. From a manuscript which accompanied the gift, we extract the following particulars in the history of the old mill:

"The want of a more effectual means of grinding the grain was sorely felt, and when, late in 1818 or in the beginning of 1819, a stone mason named Menzies came to the little settlement, bringing with him a complete set of tools of his trade, Peter McKellar, my father, who, as I have already said, possessed great mechanical talents, thought he saw the way to supply the need. There was no steam in those days, and no water mill or water power convenient to run one, therefore my father undertook to make a hand mill, or 'bragh,' as it is more correctly and euphoniously called in the original as spoken by Adam and Eve. A large granite bowlder was found on lot A, No. 1, in the township of Aldborough, at the top of the fifty-two mile creek, close to the county line of Elgin and Kent. From this bowlder

my father and Menzies made the 'bragh' stones, the former fitting them into the frame early in 1819, just as it appeared when shipped to the Colonial Exhibition in England in March, 1886. The mill, when completed, was set up in my father's house, and there was in constant use for some years by the whole settlement. I can well remember seeing the big, strong Highlandmen coming in at evening after their day's work in the clearings. Each would come with his little sack of grist, which, in his turn, he would grind, and then return to his home, often two or three miles distant."—*Dominion Milling News.*

ALASKA GOLD.

THE following extracts are taken from a letter of Dr. Willis E. Everette, being from his report to the War Department, taken while on his reconnaissance of the entire Yukon river in the summer of 1884:

The few years of mining experience which I have had in the camps of the Black Hills, Montana, and Mexico have enabled me to come to a fair sort of conclusion as to what the upper Yukon river is really worth as a mineral country, and the following information is taken from a careful personal observation of the Yukon country:

Not one "mother vein" or "home lead" has yet been discovered on the Yukon river. There have been many surface veins and infiltrated seams of quartz, together with chimneys and blowouts of mixed hematite, galena, iron and copper pyrites and magnetic pyrites; some carrying free gold and native (malleable) copper have been found by the Indians and fur traders on the Yukon, the head of White river, and off toward the heads of the Copper and Tanana rivers. Small pieces of these ores find their way to the sea coast adjacent to these rivers, and excite a belief in the minds of the miners that the interior of Alaska is filled with seams and leads of rich quartz, when in fact there are only, after several years of careful exploration, three known seams of quartz on the entire Yukon river—the first at the Lava Cliffs, near old Fort Selkirk; the second at a small point eight miles above Fort Reliance; and the third about 20 miles up the Novikaket river. All three are only chimneys or blowouts. Not a well defined foot or hanging wall has been found in any of them. The one at or near Fort Reliance has been slightly worked by the fur traders at that post. Some of the ore, which is hematite, galenite, and copper pyrites, has been taken to San Francisco, and a careful assay made of it, and although paying ore, if in a large enough body and near a mill, was valueless on account of the small lead and great distance from the coast, Fort Reliance being nearly 1,700 miles inland from the Behring sea coast, or nearly 4,000 miles from San Francisco. Thus, it certainly seems as if the Yukon interior of Alaska will never be a quartz mining country.

But of placers—ah! the very strange anomaly exists of gold being found on nearly every preglacial bench or bar, and no real gold quartz yet found in the country!

I will assure, from actual experience, any miner who understands the first rudiments of rocking and ground sluicing, that he can make fair wages on nearly any preglacial bar on the Yukon river above Fort Selkirk, though there is gold still below on the main river. The water is too deep and the yearly detritus increases too fast to allow very much success in bar washing. The chief obstacle to placer mining, however, is the great difficulty in procuring provisions and entering the country. This, coupled with the exceeding short interval between the leaving and the appearing of the ice in the river, makes it very difficult for any placer work. Hardly has a miner prospected a bar or gulch and got thoroughly to work, when the short season is at an end, and his water supply frozen up, and the intense cold during the winter months (70° below Fahrenheit zero, and by a U. S. signal service thermometer at that), and the dread of that Arctic scourge, scurvy, with a possible short supply of provisions, compels the poor Argonaut to either return back up the river and through the lake system cross the mountains to Sitka and Juneau *via* Chilcaht, or else descend the river to the first trading post and drag out the long, monotonous winter of fully eight months in absolute idleness, in company with the fur traders. If a steady supply of provisions could be depended on at these fur trading posts, it would be very different, but as they only have enough civilized food—beans, flour, bacon, etc.—for themselves, the miners must either bring in enough provisions of their own or else return to Chilcaht in disgust. This is, without any exaggeration, the cold drawn facts in regard to the mining resources of the valley of the Alaskan or Yukon interior. This part of the river freezes about the middle of September, and thaws and opens about the middle of May.

Hotelinko river is the first actual tributary to the Yukon river. This river enters the Yukon about a mile below the mouth of the canyon and on the right or northeast bank. Sixty miles below is the second tributary, but there are several minor streams or creeks that intervene. The mosquitoes are actually abominable! Running along the current and by many islands and bowlder bars, we arrive at the Bald peak. Far to the west is Lookout bluff. According to the Indian reports, it is equidistant from the head of the east fork (the main branch) of White river and the Yukon. A wide chain of very rough and broken up hilly country, heavily timbered, separates it from the Yukon river. The scenery now is many long, crooked bends, islands, snags, and drift rafts, banked in by high sand bluffs. Running by a series of sand bluffs and scrub timber, we arrive at the Boswell gold bar. Here is the only mining camp on the entire 2,500 miles of the Yukon river! I have named the great preglacial bar after the discoverer (Boswell, of Juneau, Alaska), whom I found working on the bar, with a series of rockers and the assistance of two white companions, Franklin and Madison, both of Juneau. He was waiting for the high water to go down so that they could get at the fine pay silt on the edge of the lower rim rock of the bar. The silt would then be run through the rockers and the resulting black sand and gold dust would be washed out in gold pans over a mass of quicksilver, the latter absorbing the dust and allowing the black sand to be washed out. Boswell showed me some very fine flour dust, which he had in a baking powder can—about two ounces—and in six weeks from that time the party had taken out over $2,000 worth of dust. Of course, it was an exceedingly rich pay streak, which they might never find again on the Yukon, and they exhausted the strip of silt to deep water, which renders the bar of no more value. The Boswell bar is situated on the east bank of the Upper Yukon river, about 75 miles above the Old Fort Selkirk and 560 miles from Chilcaht. The nearest fur traders are at Fort Reliance, nearly 300 miles further down the river. The bar is surrounded by a dense growth of larch, birch, and poplar. Considerable game, such as bear, moose, and caribou, and many valuable fur-bearing animals, black and silver foxes, lynxes, etc., abound all through these upper valleys. The bar consists of small bowlders and a fine gravel wash, in the concavity of a narrow horseshoe bend of about a mile in length. Its shape is like the segment of a circle whose radius is about 200 yards. It is out of the direct current of the river and slightly above the mean level.

Only by carrying the pay silt from a working streak to a series of rockers can placer mining ever be made a success on the Tanana river, and even then, for nine months out of the year, the miner would have to relinquish his rocker and turn fur trader; and as the United States treasury laws do not allow any white man to trap or kill, for sale, any of the fur-bearing animals in Alaska, and as there are just enough fur traders on the river that the Indians require for the fur trade, it would not be a very paying investment for any band of able-bodied men to leave fair daily wages and come up to prospect these frozen regions.

Certainly, they might make $10 or $20 per day to the man during this working season, and then again, they might not make 10 cents. But in the meantime, during the working season, first, they would have to be without half of the common necessaries of life; second, constantly in danger from the Tanana Indians, who would be sure to be very jealous of them, and in all likelihood cause them much trouble; third, they could only work for three months out of the twelve, and the remaining nine months be compelled to do something else for a living; fourth, and something else in this bleak interior for a miner would mean nothing else; fifth, the profit thus made during the short working season would be more than swallowed up during the long non-working season; sixth, and lastly, the very great difficulty in getting self, tools, and provisions into the country, and their extreme high cost, makes this Alaskan interior a very unfortunate mining country.

The Tanana river is distant from the head of canoe navigation on the Yukon river about 1,400 miles, and about 1,550 miles from Chilcaht, Alaska; and from the mouth of the Apkun channel, or northeast of the Yukon delta at the Behring sea, nearly 1,000 miles. Thus for a little over 1,000 miles, or to the lower ramparts, the Yukon river can safely be navigated by any sized vessel that can enter the delta. Above this point it is not safe for a steamer to ascend this river any higher, although it is often done.

GOING INTO THE POULTRY BUSINESS.

By P. H. JACOBS, Hammonton, N. J.

WHAT causes the failures in the poultry business, and what is the reason that we find but few large poultry farms in this country, yet thousands of small flocks are kept profitably in every section? Simply because the business is underrated, and *some* experience is required. With small flocks, there is more or less *involuntary* care bestowed upon them. Every member of the family takes an interest in the care of the flock, and the work, though but a small matter, is so divided among several as to really amount to nothing. But when the keeping of large numbers is attempted, it means *work*, and plenty of it.

It is a curious fact that while a man who has invested his capital in the dairy business never considers it a hardship to rise at four o'clock in the morning, milk a dozen cows, with the thermometer down below zero, clean out that number of stalls, handle the manure, feed the cows and water them, cool and ship his milk, or sit and churn it, and milk again at night, ending his work after dark—every day, and Sunday too—he will turn up his nose at the thought of getting out of bed at four o'clock for the hens, or of cleaning out the hen house every day. Yet such a man is willing to invest $100 in each cow (including shelter, etc.), and be satisfied with a clear profit, after deducting all expenses, of $20 from each cow. But should he invest $100 in poultry, he would ask for $300 profit, or—"poultry don't pay." Reader, how many such people do you know? Their name is "Legion."

Then, again, there is a belief that, because a hen is small, and can be found in every barnyard, "anybody can keep chickens."

That there is more knowledge required than may be supposed, I will demonstrate, by inviting the reader to visit any farm in his neighborhood, and he will be astonished to find how little the farmer knows about poultry. Although, when the good housekeeper purchases a fowl for the table, she forgives lack of quality, because she purchased it "from an old farmer," yet—I say it "more in sorrow than in anger"—not one "old farmer" (or young one either) in a hundred can tell a Plymouth Rock from a Dominique, or a Brahma from a Cochin.

They know literally nothing about the breeds. And yet, to infer to one of them that he did not "know all about farming" (which includes raising poultry) would insult him. Therefore, before venturing into the poultry business, one must *know* all about it, and be able to select the breeds that lay early, the hardy breeds, the market breeds, and the ornamental breeds, so as to have some *purpose* in view, and not trust, in the usual haphazard way, to anything and everything "that is covered with feathers."

The feeding of the fowls is also a very important matter. You cannot feed for *eggs* and feed for *market* with the same food and the same flock. The food that enables the hens to put on flesh rapidly is not the kind that assists them to lay eggs. There is as much difference in a laying hen and a fat hen ready for market as between a cow in full flow of milk and one that is ready for the butcher. Feeding the hens means something else than throwing down corn before them, and that something else must be acquired by practice. It cannot be easily imparted, as no two flocks are alike, and the actual condition of the fowls at the time of feeding must be understood.

You must also do furious battle with persistent enemies, who steal upon you unawares and blast your hopes just when success is smiling upon you. The cholera laughs at your efforts, and the roup mocks at your struggles, while countless myriads of lice pour in and capture your strongholds in unguarded moments. There is no disease, however, that can do one half the damage that is annually done by lice. When the hens have cholera or roup, you may notice it. But the lice will take possession, your birds droop and die, yet you will be hunting all through the pages of the poultry books for remedies, instead of suspecting lice. Some people do not wish to find the lice. It is disgraceful to have lice on the fowls. And yet the lice will appear in the cleanest of houses and in well kept flocks.

There is much to learn in the poultry business. Even experienced poultrymen make mistakes, for it takes them several seasons to learn that turkeys, ducks, geese, guineas, and chickens must be separated, "each after its kind;" that young chicks cannot be kept with old fowls; that too many hens will not thrive in one flock; that two cocks in one flock are equal to none at all; that fat hens do not lay well; that the pullets should be hatched early; that the early moulting hen makes the best winter layer; that top ventilation is disastrous; that it does not pay to "break" a setting hen; that tall combs will freeze in winter; that a hen cannot lay unless she is provided with plenty of fresh water; that hens should be made to work and scratch for a living; that the markets should be watched; that fowls should be sheltered on stormy days; that the poultry house should be cleaned daily; that—stop. The number of "thats" could be extended, but they mean plenty of *work*, and hard work too.

And do not expect too much. You can no more "make a living" on a few hundred dollars in the poultry business than you can in the dairy or grocery business. True, a few hundred dollars will pay well in the poultry business. But the "old hen" is not infallible. What is claimed is that, if you give her a fair chance, as good a chance as you give the cow, she will discount the cow every time, and will do it on less proportionate capital. The man who gets up at four o'clock in the morning, and works for the hens as he is *compelled* to do in the dairy, will not find fault with the change of occupation, so far as the profits are concerned, if a comparison be made. But "there's no million in it," though there is in it a fair recompense for all the labor and capital that may be bestowed.

I know nothing about the *pleasure* of keeping poultry, other than the pleasure derived when profitably employed, as those who venture on poultry for pleasure and profit usually get a surfeit of the former and but a small share of the latter. Yet there is nothing distasteful or repugnant in the poultry business. The work is not laborious, but constant, requiring the closest attention and most watchful care.

But I am making this article too long. Every month I endeavor to tell the readers how best to manage, to the limit of my ability, and propose, during the year, to still further endeavor to assist them. What they should do, to engage in raising poultry in large numbers, is to begin with a small flock and gradually increase. Discard the mongrels, and repel the claim that a barnyard fowl will do as well as a thoroughbred with the same attention. This can be disproved in the fact that you can, in *advance*—even before the chicks are out of the shell—by selecting the special breeds you desire, have prolific layers or persistent setters. You can describe your market fowl before it is hatched, or you may know it is a non-setter. You will know whether to build high fences or low. The very *name* of the breed will inform you of its characteristics.

But, with the barnyard fowl, you will have "ring-streaked and speckled," large and small, no uniformity, and you will know nothing about their qualities until you have raised them to maturity, the season gone, and you have sat down, pondered, and decided, the next season, to keep pure breeds, or their crosses, and *know* what you are doing.—*Farm and Garden.*

[AGRICULTURAL SCIENCE.]

SOIL TEMPERATURES.

By D. P. PENHALLOW.

WITH a general advance in our knowledge respecting the physiology of plants, it is not improbable that the temperature of the soil in its relation to plant growth may eventually prove to be of much greater significance than is realized even at the present time. Studies in this direction are properly to be regarded as of very considerable interest and importance, but their prosecution is always attended with certain difficulties which render any direct application of the results obtained not so easy as might at first appear to be the case. And to render the results of the greatest value in the deduction of general laws, it is probable that many years must be devoted to the accumulation of accurate data, as derived from special and remote localities.

It is well known that seeds require a certain temperature for germination; that some seeds require a much higher temperature than others; that while a given seed may germinate at a relatively low temperature, still that germination will be weak and the resulting plant correspondingly imperfect if the temperature fall below certain well defined limits—the inferior limit for normal growth.

Similarly, a certain temperature is requisite for the normal activity of roots in the absorption of water from the soil; and the inferior limit for normal activity in this direction is as variable for different species, but still as well defined, as for germination. In the third place, it must also be considered that, since plants have little or no temperature of their own, as derived from internal chemical changes, and since well defined temperature is essential to all the vital functions, this temperature must be derived from the medium in which the plant grows.

The temperature generated during germination may produce a sensible influence during that process, but it soon ceases, continuing to be prominent only so long as the reserve material is unexhausted. The temperature likewise evolved by some plants at the period of inflorescence is also fugitive, and cannot be regarded as producing any sensible effect upon the general temperature of the system; while such heat as is generated in the general processes of growth and respiration is so small in quantity as to be quickly conducted away, and thus produces no sensible effect.

All the plants with which the agriculturist is concerned grow in intimate contact with the soil and air, and from what has already been said respecting the relation of temperature to root activity, it is apparent that the influence of the soil is hardly, if at all, inferior to that of the air in affecting growth. A case cited by Dr. Hooker* appears to give emphasis to this view, although the conditions noted are by no means to be wholly attributed to the soil. Observations were made upon a species of calotropis to determine the relation of its temperature to that of the soil and air. The juice of the plant was found to have a temperature of 72° F. The soil gave the following temperature:

Surface	104·5° F.	3½ inches	85°
1 inch	102°	8 "	78°
2 inches	94°	15 "	72°
2½ "	90°		

It was thus found that the internal temperature of the plant was maintained at a degree equal to that of the soil at a depth of fifteen inches. This result was in large part due to the effect of transpiration, but we can hardly doubt that it must also have been due in part to the temperature of the soil itself, since all fluids at the moment of absorption must have a temperature equal to that of the soil from which they are derived; and as they ascend, although their temperature is gradually changed, they must produce a sensible effect upon the internal temperature of the whole system.

Within a few years, efforts have been made in this country to institute a series of observations upon soil temperature. The first attempt was made by the writer, at the Houghton Farm Experiment Station, the results obtained and the instruments then devised and used being given in the publications of that institution.† Following somewhat upon the plan there laid out, Dr. Sturtevant instituted a series of similar observations at the New York Experiment Station at Geneva, the results of which are stated in the annual reports of that institution.‡

Without attempting to deduce any laws—since that would be impossible upon the basis of present observations in this country—it is our present purpose to direct attention to one or two of the more important facts thus far observed, as indications of the direction in which we may look for future results, and of the possible bearing such researches are likely to have upon our knowledge of plant life. The observations thus far available embraced two years in succession at Houghton Farm—during the last year determinations were made in two distinct localities—and four consecutive years at Geneva, the record extending from the first of April to the last of October.

Goppert states that "daily variations extend to a depth of 1·5 feet, rarely 3 feet; monthly variations to 5 feet." This, however, must depend upon various conditions, *e. g.*, character of the soil and time of year, since our own observations show that hourly variations may extend to a depth of twelve inches, daily variations to a depth of eight feet, and monthly variations to a depth exceeding this. But below a certain depth these changes become slight, and are doubtless to be referred in part to other causes than the direct absorption of solar heat. Thus the hourly and daily variations are less than one degree for depths greater than three and nine inches respectively; while the monthly variations show several degrees at the greatest depth taken. As plants, however, feed chiefly within a very few feet of the surface, and as many herbaceous plants feed within a few inches of the surface, it is apparent that changes within the first three or four feet of soil are those which chiefly interest the agriculturist.

If from the results so far obtained we construct a curve based upon the mean temperature of each month for all the years over which our observations have extended, so that the curve for each month from May to September shall be represented, the co-ordinates being depth and temperature, some interesting facts are obtained. Thus, proceeding from the surface downward, in May, the curve is found to fall somewhat rapidly to a depth of two inches, from which point to three inches there is an abrupt and sensible elevation. From this latter depth to nine inches, the curve descends more gradually, though with certain variations, after which, to a depth of two feet, the descent is quite uniform and gradual.

These facts are in general true of all the summer months, with, of course, the difference that in August, as conditions become more favorable to a higher surface temperature, the descent in the curve from surface to two inches is much more abrupt, or in other words, the difference in temperature between those two levels is more marked. In September, however, since radiation from the earth's surface is more rapid than absorption of solar heat on account of the diminishing altitude of the sun, the effect of internal heat becomes manifest in the deeper layers of the soil, and causes a perceptible variation in the direction of our curve. Thus from nine inches, the descent is somewhat gradual and uniform to a depth of eighteen inches, when from this depth to twenty four inches the curve rises, showing an increase of temperature in the lower stratum of nearly one degree Fahrenheit over the superimposed layer. And as the season advances, with consequent excess of radiation from the surface layers, this upward tendency of the curve extends toward the more superficial layers of the soil, which are thus seen to have a mean temperature ultimately lower than the layers below.

From this statement of facts it appears that during the summer months, at a depth of three inches, the soil maintains a temperature which is constantly higher than that of the layers immediately superimposed; or in other words, for all layers of the soil above three inches, there is a temperature which depends not merely upon absorption of solar heat, but upon this as modified by certain conditions. These conditions are radiation and evaporation, the latter being the more important factor. The extent to which these influences operate to depress the temperature of these superficial layers below what they would otherwise have is marked, and at the surface the mean depression from this cause for all the months considered amounts to about eight degrees Centigrade. During certain months, of course, when evaporation is excessive, the depression must be even more than this. This means that during hot days, vegetation is afforded a certain measure of protection to just the extent of this depression. But it must also be kept in mind that the mechanical condition of the soil has much to do with the extent to which these influences operate.

Thus a loose, porous soil evaporates its moisture much more rapidly than a compact one. Hence its temperature must be lower. Our own observations in this respect show that the temperature between compact and porous soils may vary from 0·1° C. in the morning to 6·2° C. in the afternoon, a difference of very great importance where the growth of plants is concerned.

If we are to derive any lesson from the facts thus stated, at this early stage of our observations—and we may state them provisionally—it would be to the following effect:

A proper knowledge of the temperature of the soil must serve to guide us in reference to the time of planting particular seeds, and the depth at which they should be planted as determined by the condition and character of the soil. When the farmer gently packs the earth over the newly planted seed, he derives a measure of benefit in the higher temperature of the soil at that place, whereby germination is accelerated. Similarly, we can understand that cultivation during periods of excessive heat must tend to avert some of the evil results otherwise following from an excess of temperature.

Moreover, an application of the principles stated must lead us to realize that, in seasons of great or even ordinary dryness, a judicious system of irrigation must be of the greatest advantage, not only as supplying needed fluids for the general functions of growth, but as reducing the otherwise high temperature of the soil to a degree which is well within the danger limit and consistent with normal growth.

McGill University, Canada, March 26, 1887.

* Himalayan Journal, I.

† Agl. Physics. Houghton Farm. Ser. L. Nos. 1–4.

‡ I am indebted to the Director of the New York Experiment Station for many valuable data used in the preparation of this paper.

MODELING WAX, such as sculptors sometimes use for modeling very small figures, etc., is made of white wax melted and mixed with lard to make it workable. In working it, the tools used, the board or stone, are moistened with water, to prevent its adhering; it may be colored to any desirable tint with a dry color.

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